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CONDITIONS INFLUENCING INSIGHT AND PROBLEM-SOLVING BEHAVIOR IN THE MENTALLY RETARDED.

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THE MAJOR OBJECTIVES OF THE STUDY ARE--(1) TO SECURE A BETTER UNDERSTANDING OF THE CONDITIONS INFLUENCING INSIGHT AND PROBLEM-SOLVING BEHAVIOR IN VARIOUS TYPES OF THE MENTALLY RETARDED, (2) TO DEVELOP AND EVALUATE TECHNIQUES, INSTRUMENTS, AND PROCEDURES SUITABLE FOR THE STUDY OF INSIGHT AND PROBLEM-SOLVING BEHAVIOR IN VARIOUS TYPES OF MENTALLY RETARDED CHILDREN, (3) TO ASCERTAIN THE RELATIONSHIP BETWEEN INSIGHT AND PROBLEM-SOLVING BEHAVIOR AND RETENTION IN THE MENTALLY RETARDED, (4) AND TO COMPARE THE EFFECTIVENESS OF VARIOUS LEARNING PROCEDURES FOR THE MENTALLY RETARDED. THE FIRST STEP IN CONDUCTING THIS STUDY WAS TO IDENTIFY THE CATEGORIES OF PROBLEM SOLVING WHICH OFFER THE GREATEST PROMISE FOR MEASURING THE INSIGHT BEHAVIOR AND FOR DETERMINING THE CONDITIONS WHICH INFLUENCE THE INSIGHT AND PROBLEM-SOLVING LEARNING OF MENTALLY RETARDED CHILDREN. AFTER THIS RANGE OF INSIGHT SITUATIONS HAD BEEN IDENTIFIED, THE STUDY SELECTED TEST INSTRUMENTS AND SITUATIONS. THESE INSTRUMENTS WERE REFINED AND THEN USED TO IDENTIFY CIRCUMSTANCES, PROCEDURES, AND TECHNIQUES THAT ARE RELATED TO THE DEVELOPMENT OF INSIGHT. THE SUBJECTS OF THE STUDY WERE CHILDREN OF DIFFERENT AGES AND MENTAL ABILITY LEVELS. IT WAS CONCLUDED THAT TRAINING FOR THE MORE SEVERELY MENTALLY IMPAIRED MIGHT BE CONCENTRATED ON MANIPULATION OF THE INTENSITY-BRIGHTNESS AND THE PERIPHERAL CHARACTERISTICS OF TRAINING MATERIALS. IF MENTAL RETARDATES ARE PREDISPOSED TO STRONGEST REACTIVITY VIA THOSE PARTICULAR CHANNELS, THE CONCLUSION WOULD SEEM TO FOLLOW THAT EFFICIENT TRAINING SHOULD UTILIZE THIS PREDISPOSITION. THE FINAL SECTION OF THIS REPORT OFFERED SUGGESTIONS FOR FURTHER RESEARCH. (GC)

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CONDITIONS INFLUENCING INSIGHT AND PROBLEM SOLVING BEHAVIOR IN THE MENTALLY RETARDED

Kai Jensen, Director

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CONDITIONS INFLUENCING INSIGHT AND PROBLEM SOLVING BEHAVIOR IN THE MENTALLY RETARDED

I. GENERAL INTRODUCTION

This investigation was concerned with a study of certain factors influencing insight and problem solving behavior in the mentally retarded. For this purpose two groups of retardates differing in general developmental maturity and two different types of problems were utilized.

One type of problem measured performance on a sequence of six different block-assembly problems having the same relevant cues for solution, tapered pegs of identical dimensions, but having varied peripheral cues such as circular shapes, tapered and untapered, and triangular pieces of equilateral and isosceles shape. This type of problem was also presented in an advanced form composed of three sets of blocks involving non-circular tapered pegs of varying shapes. These three advanced problems were presented simultaneously and confronted the subjects with problems characterized by varied relevant cues and identical peripheral cues, contrary to their preceeding experience.

The second type of problem involved the use of a tilting apparatus by means of which the apparent size and shape of a plane figure was varied systematically. The subjects were directed to match the stimulus with one of five photographs taken at five different uniformly-spaced positions of tilt. The purpose was to study the functions of visual pattern discrimination and abstraction of interrelationships among relevant peripheral cues.

The major terms needing clarification are discussed in the next section.

Insight and Problem Solving Behavior

In the present healthy state of stimulating diversity in theoretical interpretations of behavior (41, 46), this investigation of insight and problem solving behavior was facilitated by ample freedom for the "fresh conceptual start". The rigorous demands for a new start seemed best satisfied by the theoretical eclecticism and the methodological positivism advocated by Marx (79).

This approach certainly required a careful examination of pertinent current hypothetical constructs. Some of these carry a crushing load of inaccurate, misleading, irrelevant, or vague untestable "meaning" (75). The hypothetical construct "insight" especially warranted close scrutiny because of its great variety of meanings and its controversial history (25, 104). In the decade of the 1950's the term gained prominent usage in such varied contexts as psychoanalysis (70, 78, 91, 102, 132), personality measuring scales (33, 34, 35, 40, 54, 94), group dynamics (17), behavior pathology (101, 113), psychotherapy in general (10, 78, 90, 92, 119, 123), educational philosophy (7, 85), latent learning and reasoning (24, 25), basic thought processes (112), and maze learning (47, 95).

The term has also been used by unwitting victims of circular reasoning. It has been used as a "profound" explanation of some sudden idea or problem solution. It has gained anthropomorphic explanatory powers in some imaginations, e.g., the vague notion of the "little man" inside the brain who operates "mental processes". In the 1920's some Gestalt psychologists assigned the term great explanatory powers with phylogenetic implications (14). Other psychologists assigned the term more limited explanatory powers in "open" problem-solving situations where all the necessary information for solution of the problem was readily available to the sense organs of the subject.

Attempts to define insight in terms of observable behavior have produced controversy rather than clarification. The definition of insight as sudden learning or one-trial problem solution encountered the difficulty of properly evaluating antecedent learning (25, 87), to state the matter as innocuously as possible. The psycho-analysts and psychotherapists have now purloined the term and given it many additional hues of meaning in terms of self-concept, self-awareness, self-understanding, self-acceptance, etc. (78, 92, 132).

Circular, explanatory, and anthropomorphic usages of the term were flatly rejected from consideration for this study. Any attempt to define the term operationally in terms of measurable behavior posed a serious risk of ambiguous interpretations if indeed a satisfactory definition could be produced where others failed.

Apparently the term began its controversial career in the primate laboratories (65, 66, 126, 127, 128). Kohler and Yerkes soon received support for their hypothetical construct from Bingham (13) and Kluver (64). Although the term was intended to serve as a better way to understand a special category of sudden learning than Thorndike's (115, 116, 117) theory offered, it was vigorously challenged in other primate laboratories (63, 71, 99, 100).

McGeoch (81) seemed quite certain in 1942 that the term had nothing to offer that couldn't be better explained in terms of trial-and-error learning theory. Birch (14) then took great pains to show that "insightful" behavior was really the result of the organism's ability to re-organize the relational data acquired in its past experience so as to produce new behavior. A decade earlier Maier and Schneirla (77) had expressed a similar view of problem solving behavior. In 1951 Hovland (58) was still willing to let the matter rest where McGeoch had left it. At the same time, however, Spence (104) was inclined to make more definite disposal of the term by deliberately relegating it to the category of questionable, if not useless, untestable higher-order processes.

In the same year Harlow (43) chose to substitute an intervening variable (75), learning set, with a precise operational definition in place of the term, insight, in his interpretations of problem solving behavior in the primate laboratory. Harlow's choice has influenced the pattern of interpretation of learning behavior in experiments throughout the decade of the 1950's. Special applications of the "learning set" variable have received considerable development in terms of S-R theory (27, 124). Other applications with particular relevance for the present study have been developed in research on mental retardation (4, 9, 29, 62).

About thirty years after his original publications on behavior supposedly involving insight, Kohler (67) rounded out the story with passing notice to his earlier "somewhat misleading" use of the term, insight, and took account of the contribution of Harlow (43). However, it is quite clear that Kohler does not consider the term useless for the theoretical formulations of Gestalt psychology.

It also seems quite clear that Kohler is still pushing the term, insight, as a hypothetical construct into the breach of that great unknown "process" of problem solving. It is not at all clear, however, whether his idea of this "process" is basically biochemical, neurophysiological, neuro-anatomical, philosophical, vaguely anthropomorphic, or otherwise.

By way of contrast, nevertheless, concerted efforts have been made to press forward the search for the basic organismic variables that influence behavior, in terms that can be understood and utilized effectively by investigators in many inter-related scientific disciplines (46). Likewise, the present study has attempted to identify and define empirically variables found to be operating significantly in "insight" and "problem-solving" behavior, using these latter terms in a generic sense only.

Mental Retardation

The concept of mental retardation has, in the twentieth century, come to encompass a substantially greater percentage of the population than it did in the early nineteenth century when Itard (60) and Seguin (97, 98) became interested in the defect of feeblemindedness, or in ancient Sparta when the unfit were simply exterminated. The bulk of this trend toward expansion of the concept has probably resulted from the impact of compulsory education upon educational practices (53). In order to relieve perplexed educators, Binet and Simon developed a new technique for diagnosing more individuals (12). Heck (53), Goddard (38), and Strauss and Lehtinen (111), among others, have provided a good historical review of the early development of special education.

If the trend toward relegating more people to a "sheltered" participation in a highly complex society, is continued then the burden of their protection will have to be borne by a proportionately dwindling "elite" population. Perhaps the impact of this burden will spur efforts to rehabilitate the mentally retarded, to reduce the incidence of mental defect, and/or to resort to Spartan expediency. Indicative of aroused interest in the problem is the marked increase in research in this field in the late 1950's (3, 4, 5, 6, 9, 20, 21, 22, 28, 29, 30, 31, 32, 51, 57, 62, 129, 130, 131).

An operational definition of mental retardation, in conformity with the methodological framework of logical positivism (11, 105), has been seriously considered (19, 20) but still lacks a satisfactory formulation. The usual clinical approach considers anyone as mentally defective who, for example, obtains a Binet I.Q. of 70 or less and a Vineland S.Q. of 70 or less and whose deficiency is, or is not, considered necessarily incurable, depending upon the clinician. Schmidt (96) and Sarason (93) would seem to discount incurability as a criterion. The official approach of the American Association on Mental Deficiency (50) is apparently going to emphasize the use of the two dimensions of intellect and adaptive behavior. The projected plan would scale objective intelligence tests in units of standard deviation only and would scale adaptive behavior in terms of social, academic, or vocational competency as appropriate for varying age levels. Presumably these latter measures will be standardized somehow (52).

Eisman (28) would prefer a diagnostic instrument that would sample behavior in a variety of different learning situations in order to define mental retardation adequately. Certainly an intelligence test score alone is not adequate according to Levy and Cuddy (73), Gardner (36), and Masland, Sarason, and Gladwin (80). The term "endogenous" has no theoretical usefulness as a construct (that is, does not possess "meaning II" in Bergmann's terminology) according to Jastak (61) and according to the findings of Eisman (28). Similarly, Benoit (8) sees the concept of "familial" retardation as "an egregious piece of circular inference".

A quarter of a century ago Kurt Lewin (74) defined mental retardation in terms of the rigidity of boundaries within the life space of such individuals. There is quite a chasm between this kind of definition and an operational definition satisfying to logical positivists. However, Kounin (69) considered the definition useful for generating a testable hypothesis. Recently, nevertheless, Plenderlith (88), followed shortly by two related studies (110, 131), failed to find any support for the conception of rigidity advanced by Kounin.

Benoit (8) considered possible definitions of mental retardation as a learning deficit in terms of Hull's (59) principles of behavior and in terms of Kohler's (68) satiation theory. He found the underlying assumptions of the theories of Kohler and Hull to be too "intricate" and too "fragile". It was not clear how he arrived at this judgment nor what specific assumptions he had in mind.

The most constructive formulation of a definition of mental retardation and the most careful analysis of the implications of the definition have, nevertheless, been contributed by Benoit (8). For this contribution he chose the theoretical framework of Hebb's (49) conceptions of the organization of behavior. There is considerable resemblance in abstract relationships between Hebb's theory and the theory advanced more recently by the British psychologist, Deutsch (23, 25).

According to the Hebbian frame of reference, Benoit defines mental retardation as follows:

"Mental retardation may be viewed as a deficit of intellectual function resulting from varied intrapersonal and/or extrapersonal determinants, but having as a common proximate cause a diminished efficiency of the nervous system (beginning with an impaired irritability and further involving a lowered capacity for impulse transmission and for developing primitive and integrating cell chains through interfacilitating interneuronal connections), thus entailing a lessened general capacity for growth in perceptual and conceptual integration and consequently in environmental adjustment."

The value of such a definition is that it will guide research into the determination of the essential characteristics of slowly developing mentality and the determination of precisely how such slow mentality actually evolves in the first place. It is easy to get lost in the measurement of the intellectual shortcomings of the mentally retarded and forget to search for underlying reasons for their shortcomings. Benoit (8) criticized the fad in the late 1950's of getting lost in the behavioral implications of etiological differences. He also criticized the rash of cross-sectional investigations of how the mentally retarded differ from the normal in various areas of behavior (3, 62, 88, 131, and others). Crucial research, instead of making omnibus comparisons, will search for the essential nature of functioning in mental retardation and attempt to discover why the mentally retarded differ so unfavorably and whether or not they, and perhaps society too, are indeed incurable. Morrison (84) has recently re-emphasized the Pavlovian injunction for scientists to try to penetrate to the laws that govern observed facts.

Subjects

Two main groups of mentally retarded subjects were selected for this investigation. Each group was finally comprised of 30 individuals who met all of the following conditions, viz.,

(a) Participation in a program of special education for at least 6 months prior to these experiments.

(b) Availability of records showing developmental history and evaluations by clinicians.

(c) Sustained moderately high motivation throughout the experiments.

(d) Completion of both experiments with an uncontaminated set of performance data for each.

(e) Clear-cut success or failure on the advanced problem-solving test described in Experiment I.

These two main groups of subjects were selected for the purpose of maximizing inter-group differences in neurophysiological maturation and general developmental maturity insofar as these differences were determined by chronological age. The first group was composed of youth and adults in the vocational training classes at Southern Colony Training School at Union Grove, Wisconsin. The second group was composed of children in the primary special classes of the Madison Public Schools, Madison, Wisconsin. See the summary of descriptive data on these groups in Tables 1.1 through 1.9. Compare also the summary of supplementary information in Table 1.9 of Experiment I with that in Table 1.5 of Experiment II.

Table 1.1 Description of the High-Mental-Age Group at Southern Colony Training School.

Subjects	CA*	MA*	IQ	ΣX_1
AAAY	204	121	67	14002
ABAX	225	115	64	12243
ACAX	247	112	62	16765
ADAX	153	103	67	18287
AEAX	299	115	64	13295
AFAX	209	133	74	13494
AGAY	200	122	68	9053
AHAX	149	106	71	20244
AIAX	394	144	80	14943
AJAY	229	144	80	17624
Range	245	41	18	11191
Mean	230.9	121.5	69.7	14995.0
Standard Deviation	68.2	13.8	6.1	3121.7
Standard Error $\bar{X}$	21.6	4.4	1.9	987.2

* Age in months.

Table 1.2 Description of the Middle-Mental-Age Group at Southern Colony Training School.

Subjects	CA	MA	IQ	ΣX_1
AKBY	220	103	57	27484
ALHX	180	99	55	12185
AMHX	355	99	55	10764
ANBY	201	106	59	11938
AOBY	208	99	55	24239
APBY	517	95	53	20313
AQHX	237	99	55	16804
ARHX	182	97	54	8056
ASBY	202	112	62	21271
ATBY	308	110	61	22021
Range	337	17	9	19428
Mean	261.0	101.9	56.6	17507.5
Standard Deviation	100.8	5.4	2.9	6179.8
Standard Error $\bar{X}$	31.9	1.7	0.9	1954.2

Table 1.3 Description of the Low-Mental-Age Group at Southern Colony Training School.

Subjects	CA	MA	IQ	ΣX_1
AUCY	213	54	30	14515
AVCY	225	65	36	22594
AWCY	487	76	42	17258
AXCY	220	59	33	21857
AYCX	217	77	43	9673
AZCX	247	94	52	11979
BACX	380	68	38	20071
BBCY	335	94	52	25441
BCCX	238	77	43	11862
BDCY	216	88	49	18814
Range	274	40	22	15768
Mean	277.4	75.2	41.8	17406.4
Standard Deviation	88.2	13.2	7.3	4987.4
Standard Error $\bar{X}$	27.9	4.2	2.3	1577.2

Table 1.4 Description of the High-Mental-Age Group at Madison Public Schools.

Subjects	CA	MA	IQ	ΣX_1
BEAX	142	104	73	11148
BFAY	153	115	75	19065
BGAX	145	106	73	12721
BHAX	114	92	81	20938
BIAY	138	106	77	21307
BJAX	137	99	72	19227
BKAX	98	73	74	15448
BLAX	107	86	80	16178
BMAY	102	78	76	23614
BNAY	134	101	75	20207
Range	55	42	9	12466
Mean	127.0	96.0	75.6	17985.3
Standard Deviation	18.8	12.8	2.8	3784.8
Standard Error $\bar{X}$	5.9	4.0	0.9	1196.9

Table 1.5 Description of the Middle-Mental-Age Group at Madison Public Schools.

Subjects	CA	MA	IQ	ΣX_1
BOBY	91	58	64	24311
BPBX	109	75	69	26840
BQBX	139	97	70	13276
BRBY	96	62	65	21035
BSBX	92	63	69	23416
BTBX	91	62	68	27446
BUBY	98	64	65	25621
BVBX	99	66	67	17034
BWBX	93	60	65	20536
BXBY	108	75	68	16798
Range	48	39	6	14170
Mean	101.6	68.2	67.0	21631.3
Standard Deviation	13.9	11.0	2.0	4506.5
Standard Error $\bar{X}$	4.4	3.5	0.6	1425.1

Table 1.6 Description of the Low-Mental-Age Group at Madison Public Schools.

Subjects	CA	MA	IQ	ΣX_1
BYCY	109	64	59	24671
BZCY	91	56	61	30598
CACX	105	59	56	20736
CBCY	101	61	60	21155
CCCY	102	56	55	18631
CDCX	95	58	61	31167
CECY	96	59	61	27696
CFCY	98	62	63	19595
CGCX	97	55	57	25569
CHCY	103	61	59	21155
Range	18	9	8	12536
Mean	99.5	59.1	59.3	24097.3
Standard Deviation	4.9	2.8	2.4	13654.9
Standard Error $\bar{X}$	1.6	0.9	0.8	4318.1

Table 1.7 Summary of the Descriptions of the Three Groups from the Southern Colony Training School.

Groups	Range	Mean	S.D.	S.E.
. . . . Chronological Age				
High	245	230.9	68.2	21.6
Middle	337	261.0	100.8	31.9
Low	274	277.4	88.2	27.9
. . . . Mental Age				
High	41	121.5	13.8	4.4
Middle	17	101.9	5.4	1.7
Low	40	75.2	13.2	4.2
. . . . Intelligence Quotient				
High	18	69.7	6.1	1.9
Middle	9	56.6	2.9	0.9
Low	22	41.8	7.3	2.3
. . . . Total Block-Assembly Test Score				
High	11191	14995.0	3121.7	987.2
Middle	19428	17507.5	6179.8	1954.2
Low	15768	17406.4	4987.4	1577.2

Table 1.8 Summary of the Descriptions of the Three Groups from the Madison Public Schools.

Groups	Range	Mean	S.D.	S.E.
. . . . Chronological Age				
High	55	127.0	18.8	5.9
Middle	48	101.6	13.9	4.4
Low	18	99.5	4.9	1.6
. . . . Mental Age				
High	42	96.0	12.8	4.0
Middle	39	68.2	11.0	3.5
Low	9	59.1	2.8	0.9
. . . . Intelligence Quotient				
High	9	75.6	2.8	0.9
Middle	6	67.0	2.0	0.6
Low	8	59.3	2.4	0.8
. . . . Total Block-Assembly Test Score				
High	12466	17985.3	3784.8	1196.9
Middle	14170	21631.3	4506.5	1425.1
Low	12536	24097.3	13654.9	4318.1

Table 1.9 Summary of the Descriptions of the Combined Groups from Southern Colony Training School and Madison Public Schools.

Statistic	CA	MA	IQ	ΣX_1
. . . . Southern Colony Training School				
Range	338	90	50	19428
Mean	256.4	99.5	56.0	16636.3
Standard Deviation	88.9	22.2	12.8	5061.4
Standard Error $\bar{X}$	16.2	4.0	2.3	924.1
. . . . Madison Public Schools				
Range	62	60	26	20019
Mean	109.4	74.4	67.3	21238.0
Standard Deviation	18.4	18.5	7.1	4905.4
Standard Error $\bar{X}$	3.4	3.4	1.3	895.6

The identity of each subject in this study was protected by assigning a code word in lieu of the subject's name. Detailed information bearing upon the general developmental maturity of each subject is presented in a series of tables in the experiments reported below. Each subject's total performance score (X_1) on one of the experiments has also been incorporated in both series of tables. See Tables 2.1, 2.2, 2.3, 2.4, and 2.5 and also the supplementary tables in the second experiment, viz., Tables 1.1, 1.2, 1.3, and 1.4.

The subjects for the second experiment were in all cases the same 60 mentally retarded individuals previously described. All the subjects participated in both experiments as one general experience; for any given subject the experience occurred during an average period of 45 minutes of authorized participation. Randomly, half of the subjects performed first in Experiment I, and the other half performed first in Experiment II.

The experimenter was introduced to all subjects by the classroom teachers concerned prior to participation in the experiment. Rapport was easily established with all the subjects finally selected. The subjects generally came to the tasks with a moderately high desire to please the experimenter. This motivation seemed to be associated primarily with the importance of somewhat similar diagnostic situations in the past experience of the subjects at the Southern Colony Training School. On the other hand, it was

Table 2.1 Description of the High-Achievement Group at Southern Colony Training School.

Subjects	CA	MA	IQ	ΣX_1
ABAX	225	115	64	12243
ACAX	247	112	62	16765
ADAX	153	103	67	18287
AEAX	299	115	64	13295
AFAX	209	133	74	13494
AHAX	149	106	71	20244
AIAX	394	144	80	14943
ALBX	180	99	55	12185
AMBX	355	99	55	10764
AQBX	237	99	55	16804
ARBX	182	97	54	8056
AYCX	217	77	43	9673
AZCX	247	94	52	11979
BACX	380	68	38	20071
BCCX	238	77	43	11862
Range	245	76	42	12188
Mean	247.5	102.5	58.5	14044.3
Standard Deviation	74.8	19.5	11.6	3567.7
Standard Error $\bar{X}$	19.3	5.0	3.0	921.2

Table 2.2 Description of the Low-Achievement Group at Southern Colony Training School.

Subjects	CA	MA	IQ	ΣX_1
AAAY	204	121	67	14002
AGAY	200	122	68	9053
AJAY	229	144	80	17624
AKBY	220	103	57	27484
ANBY	201	106	59	11938
AOBY	208	99	56	24239
APBY	517	95	53	20313
ASBY	202	112	62	21271
ATBY	308	110	61	22021
AUCY	213	54	30	14515
AVCY	223	65	36	22594
AWCY	487	76	42	17258
AXCY	220	59	33	21857
BBCY	333	94	52	25441
BDCY	216	88	49	18814
Range	317	90	50	18431
Mean	265.4	96.5	53.6	19228.3
Standard Deviation	100.2	24.3	13.4	5007.3
Standard Error $\bar{X}$	25.9	6.3	3.5	1292.9

Table 2.3 Description of the High-Achievement Group at Madison Public Schools.

Subjects	CA	MA	IQ	ΣX_1
BEAX	142	104	73	11148
BGAX	145	106	73	12721
BHAX	114	92	81	20958
BJAX	137	99	72	19227
BKAX	98	73	74	15448
BLAX	107	86	80	16178
BPHX	109	75	69	26840
BQHX	139	97	70	13276
BSHX	92	63	69	23416
BTHX	91	62	68	27446
BVHX	99	66	67	17034
BWHX	93	60	65	20536
CACX	106	59	56	20736
CCCX	102	56	55	18631
CVCX	96	62	65	19696
Range	54	50	26	16298
Mean	111.4	77.3	69.0	18878.0
Standard Deviation	18.8	17.5	7.1	4619.2
Standard Error $\bar{X}$	4.8	4.5	1.8	1192.7

Table 2.4 Description of the Low-Achievement Group at Madison Public Schools.

Subjects	CA	MA	IQ	IX_1
BPAY	153	115	75	19068
BIAY	138	106	77	21307
BMAY	102	78	76	23614
BNAY	134	101	75	20207
BOBY	91	58	64	24311
BRBY	96	62	65	21035
BUBY	98	64	65	25621
BKBY	106	75	68	18798
BTCY	109	64	59	24671
BZCY	91	56	61	20698
CBCY	101	61	60	21156
CDCY	98	58	61	21167
CHCY	96	59	61	27696
CGCY	97	55	57	25869
CHCY	105	61	59	21156
Range	62	60	20	14369
Mean	107.6	71.5	65.6	23397.9
Standard Deviation	18.2	19.1	6.8	3956.1
Standard Error $\bar{X}$	4.7	4.9	1.7	1021.5

Table 2.5 Summary of the Descriptions of the Combined High-Achievement Groups and the Combined Low-Achievement Groups.

Statistic	CA	MA	IQ	ΣX_1
. . . .	Combined High Groups	. . . .		
Range	303	86	43	19390
Mean	179.4	89.9	63.7	16461.2
Standard Deviation	87.2	22.4	11.0	4782.6
Standard Error $\bar{X}$	15.9	4.1	2.0	873.2
. . . .	Combined Low Groups	. . . .		
Range	426	90	50	22114
Mean	186.4	84.0	59.6	21413.1
Standard Deviation	106.9	25.1	12.2	5013.5
Standard Error $\bar{X}$	19.5	4.6	2.2	915.3

seemingly associated with a very important need for social acceptance and recognition on the part of the subjects in the Madison Public Schools.

Motivation was easily maintained at a level adequate to produce deliberate responsiveness to the problems in each experiment by means of a random pattern of warm verbal encouragement alternating with silence during which the experimenter kept absorbed in recording responses and, when necessary, managing materials. The encouragement consisted of praise for being a good helper and a good friend. The subjects readily got the idea that their cooperation was appreciated. At no time did the experimenter indicate that a response was right or wrong by any word, gesture, or facial expression.

While most of these subjects were capable of expressing and understanding only very limited ideas by oral communication, they quickly grasped the directions for these experiments. The simple directions were conveyed by both pantomime and oral expression simultaneously. The gestures adequately conveyed the entire directions as was convincingly demonstrated in the case of a deaf and mute subject at the Southern Colony Training School.

II. EXPERIMENT I

Introduction

The present experiments were designed to identify some of the basic components of the behavior of mentally retarded individuals and groups in the learning of repetitively presented problem situations. McPherson (82) reviewed the small number of experimental studies in this specific area up to 1948. Briefly the review dealt with the studies of Doll and Aldrich (1, 2, 26) at the Vineland Laboratory in the early 1930's and with a study by Gardner (36) over a decade later. These studies made very noteworthy contributions to the identification of important components, viz., the relationship between the degree of mental impairment and the amount of simplification of problems for learning, the utility of various measures of improvement, the effect of motivation, individual variability, perseveration, position preferences, transfer of training, and distraction.

In the mid-1950's further investigation of this specific kind of learning in repetitively presented problem situations was conducted by Tizard and Loos (118). They studied the basic components of behavior in adult imbeciles. Specifically they were interested in whether they could obtain transfer of training and Harlow's "learning set" after practice on a fairly complex laboratory task and whether they could obtain retention of gains after one month. All these basic phenomena were found to be functioning in such behavior. Kaufman and Peterson (62) recently confirmed the basic component of perseveration in problem-solving behavior in eight mentally retarded children.

A particular variety of learning set usually called "attention set" was investigated by Bensberg (9). The effect of inappropriate attention set induced by pre-training was determined to be a significant factor. Wickens (124) recognized attention set or perceptual bias as an important basic component of behavior in general and attempted to account for it in postulates derived from S-R theory.

Stevenson and Iscoe (109) studied the factor of transposition in visual discrimination among mentally retarded subjects and found their rate of learning much slower than that of normal children of the same mental age.

House and Zeaman (56) compared the performance of mentally retarded subjects on color-form discrimination learning with that of the naive monkeys in Harlow's study (42) using an experimental procedure as similar as possible to Harlow's. They found a high incidence of failure to learn simple color-form discrimination among a group of imbecile children; their subjects being clearly less able than the monkeys to learn such discriminations. This particular outcome per se is less important than the evidence of underlying impairment of growth in perceptual and conceptual integration. The nature of this impairment is further studied in both Experiments I and II of the present investigation.

The nature of this impairment was also studied by House, Orlando and Zeaman (55), who determined that mental defectives make little or no use of the negative cue in a two-choice discrimination. The very next year House and Zeaman (57) pressed the search to isolate the effects of a single rewarded or unrewarded trial of a two-choice discrimination utilizing the experimental technique developed by Harlow and Hicks (45) for isolating such effects. Not only were the effects of different first-trial procedures isolated, but the different types of primary error factors were analyzed. They classified the error factors into the same five types originally defined by Harlow (44) in primate research:

(a) response shift
(b) stimulus perseveration
(c) position habit
(d) running order
(e) differential cue

The results showed that mental defectives make more position-habit errors but fewer differential-cue errors and response-shift errors in later trials than monkeys do.

Their results also showed a very significant failure in acquisition of learning sets over the series of 60 problems of the two-choice discrimination type. This points to the need for penetrating study of the spatial-pattern vision and perception of mental defectives.

The underlying reasons for failure in acquisition of learning set and for the predominance of position-habit errors still remain to be discovered. The present investigation has attempted to discover the relationship between such a characteristic impairment and the basic nature of attention set and spatial-pattern discrimination. The powerful interacting effects of facilitation and inhibition by transfer served as tools to identify the actual positive cues in organismic, intrapersonal terms. The frequently unrecognized assumption, that the actual positive and negative cues in any given problem situation can be specified by the experimenter in extrapersonal terms only, warrants critical scrutiny (86). It is wise to determine empirically how and what cues are being used in any given situation by the mentally retarded.

Purpose:

The purpose of the first aspect of the investigation was to identify the essential nature of the intervening variables which were measurably predominant in the behavior of mentally retarded subjects during the solving of block-assembly problems in the absence of directive reinforcement.

The design of this experiment, shown in Table 2.6, permitted intergroup and intragroup comparisons, the study of

Table 2.6 The Repeated-Measurements Design for Experiment I with the Factorial Notation ($\underline{X}_{ghijk}$).

			Block-Assembly Problems		
Population	Achievement		1	.	J
Samples (g)	Groups (h)	Individuals (i)	Components 1 . K	...	Components 1 . K
Southern Colony Training School	High	1 . 15			
	Low	1 . 15			
Madison Public Schools	High	1 . 15			
	Low	1 . 15			

intra-problem and inter-problem variables, and the assessment of individual differences in performance. This experimental design provided an exploratory test of several hypotheses concerning the behavior of mental retardates under the prescribed experimental conditions. These hypotheses held that behavior in mental retardation would be characterized by:

Hypothesis 1. A significant inter-group variability in problem-solving performance as a function of the general developmental maturity of the different groups of subjects.

Hypothesis 2. A significant inter-problem variability in performance as a function of proactive inhibition.

Hypothesis 3. A significant inter-problem variability in performance as a function of facilitation by transfer.

Hypothesis 4. A significant intra-problem variability in performance as a function of designed convergence of attention on the relevant cues.

Hypothesis 5. A significant inter-group by inter-problem interaction in performance as differential group reactions to the functions of facilitation and inhibition by transfer.

Hypothesis 6. A significant inter-group by intra-problem interaction in performance as a function of differential group attention set.

Hypothesis 7. A significant inter-problem by intra-problem interaction in performance as a function of pro-active inhibition and attention set.

Hypothesis 8. A significant inter-problem by intra-problem interaction in performance as a function of facilitation by transfer and attention set.

Hypothesis 9. Significant individual idiosyncracies in inter-problem and/or intraproblem variability in performance as a function of dominant organismic characteristics that may be diagnostic in new dimensions.

Method:

Apparatus:

The apparatus consisted of two general types: (a) the block-assembly sets and (b) the electrical recording apparatus.

The data analyzed in this experiment were obtained by the use of six different block-assembly problems all having the very same key ordering factor in correct assembly, viz., the tapered center post. Each problem was made up of five wooden blocks constructed to fit snugly on the tapered center post in only one correct order. See Figures 1-6 for a typical presentation array of each problem. At this initial stage of each problem, the probability of making a

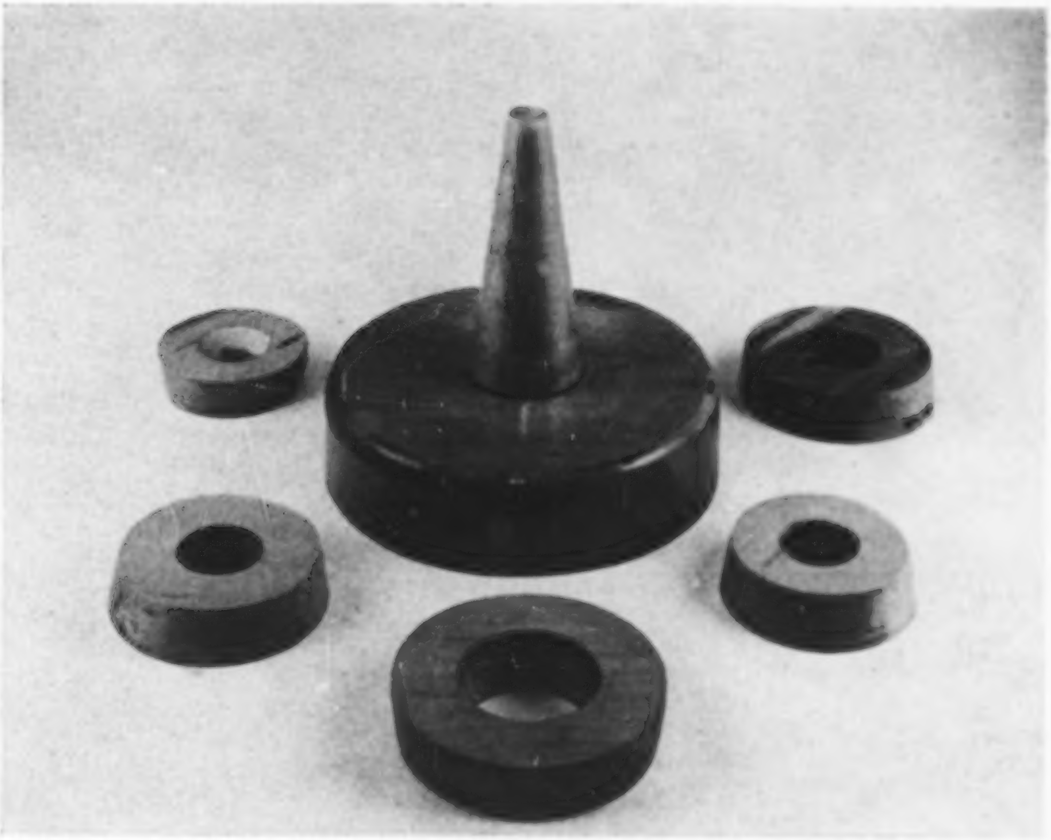

Figure 1. PRESENTATION ARRAY 1

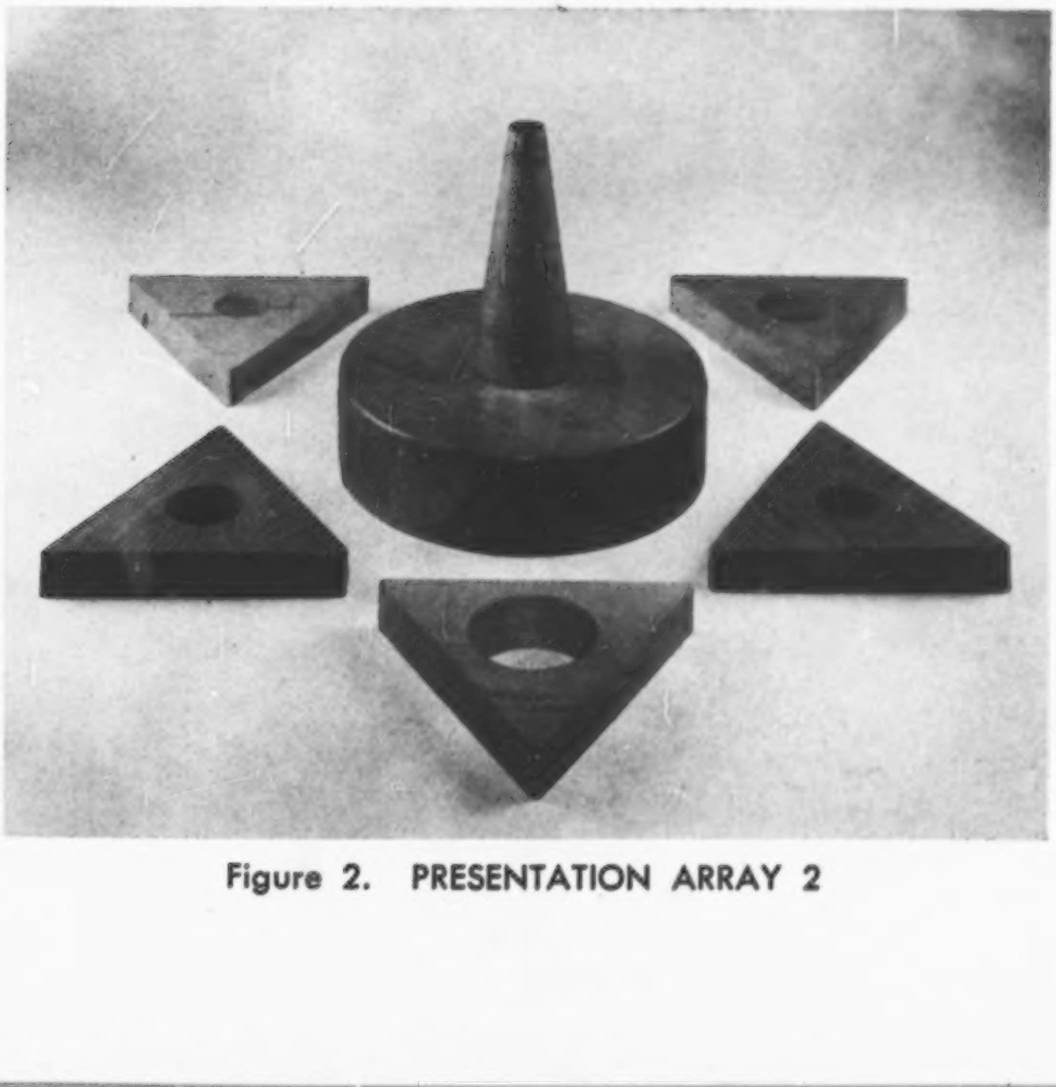

Figure 2. PRESENTATION ARRAY 2

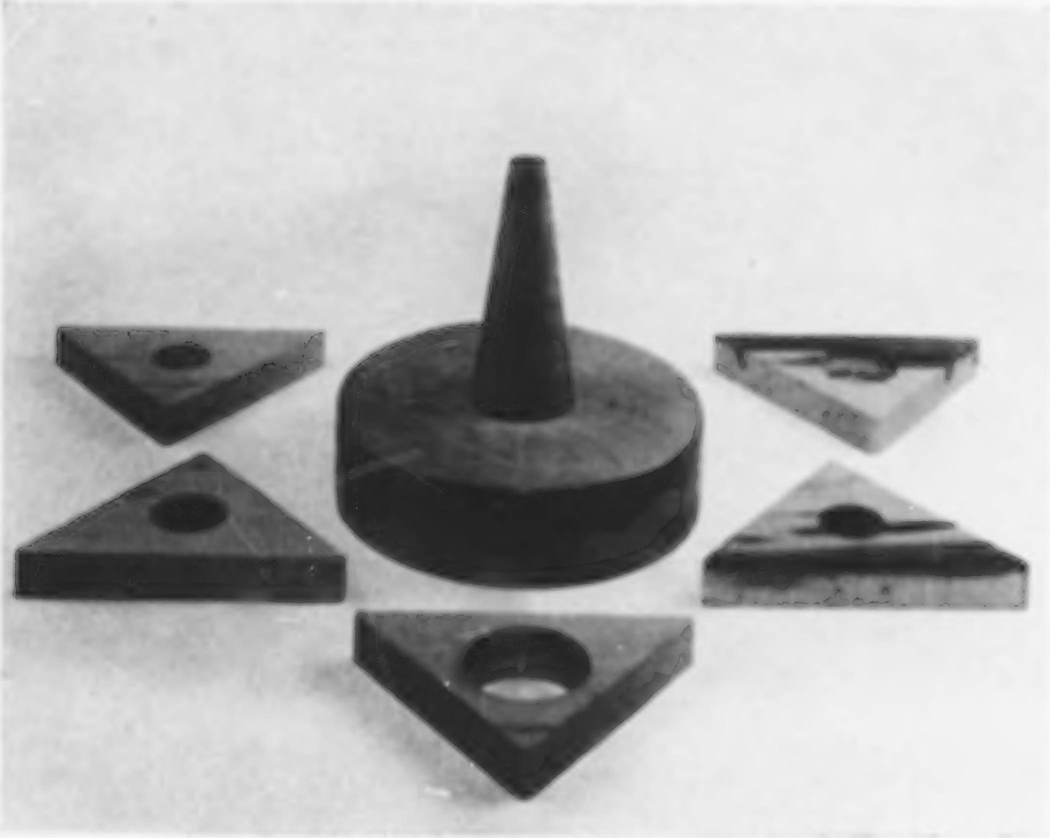

Figure 3. PRESENTATION ARRAY 3

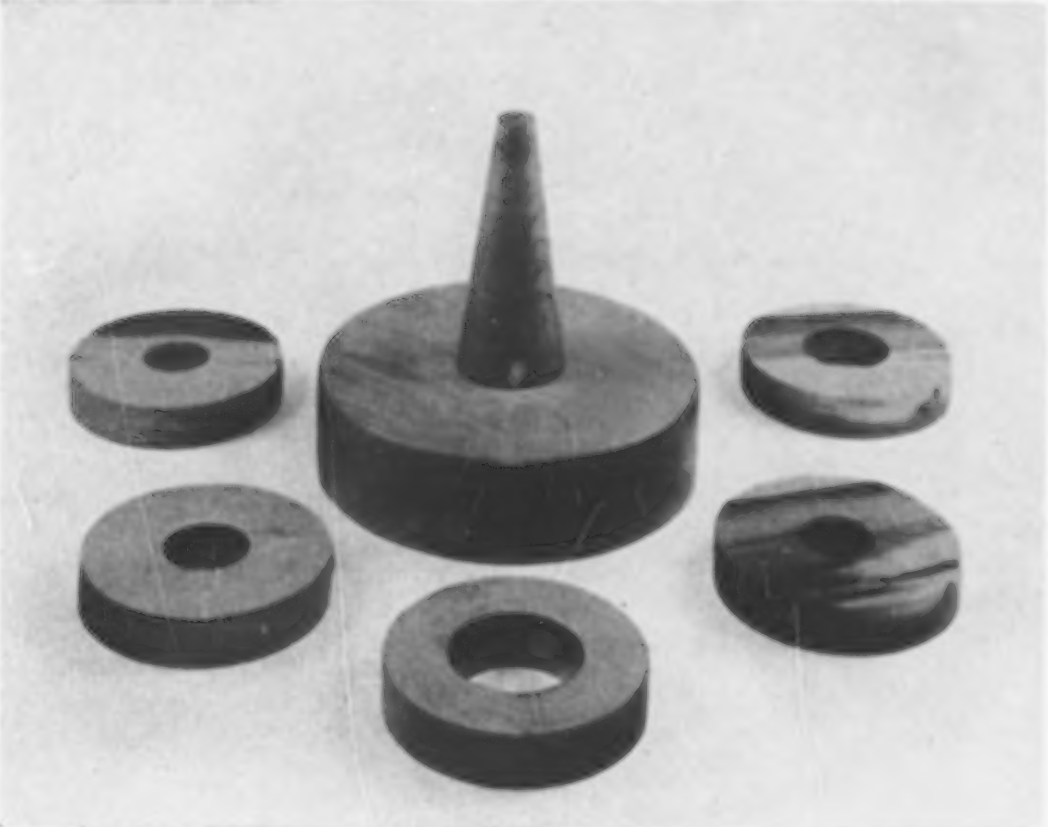

Figure 4. PRESENTATION ARRAY 4

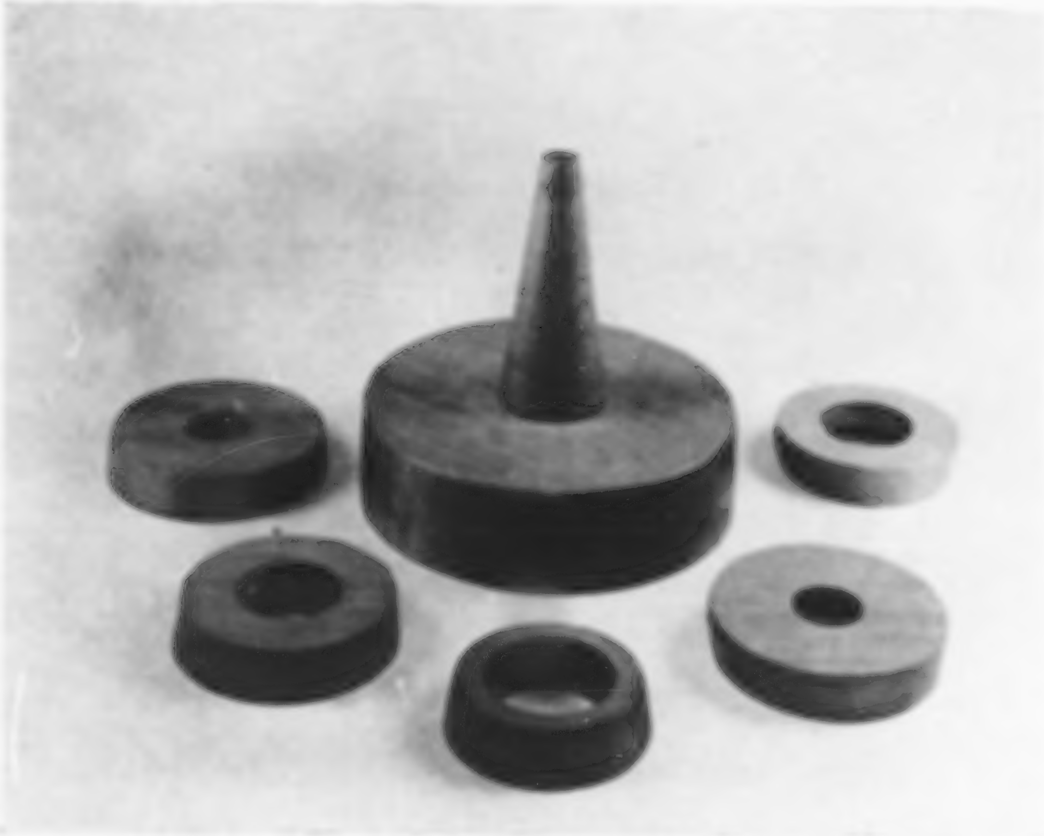

Figure 5. PRESENTATION ARRAY 5

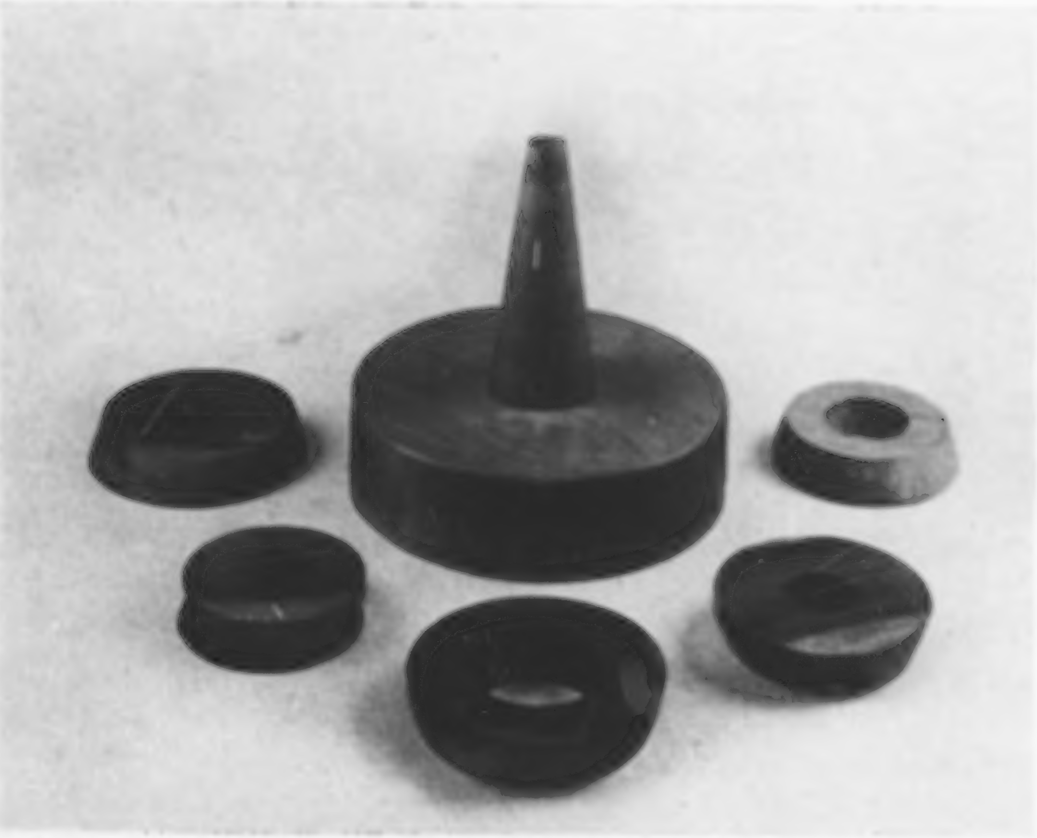

Figure 6. PRESENTATION ARRAY 6

correct response on the first, or bottom, block of all six problems was $(1/5 \times 1/2),^6$ or $p = .000001$. The subject had a choice of five blocks and, in addition, had to make a choice of right or wrong side up for each block. From this remote once-in-a-million chance, the probability increased to $(1/2),^6$ or $p = .0156$, on the last, or top, block of all six problems. Even at this stage, correct responses were significant by the usual standards.

The sequence for presentation of these six problems was held constant for all subjects. The sequence is shown in Figures 1-6. The relative positions of the five blocks in each separate presentation array were varied systematically for cancellation of position effects by means of a 5 x 5 Latin square. Random variation of point of entry and direction of reading in the square provided a convenient system. The columns of the Latin square carried headings, vix., D-U-D-U-D, to indicate which three blocks should be turned upside-down in the array presented to the subject.

In addition to these six block-assembly problems used for collection of performance data, and at the same time serving as a pre-training sequence for the subsequent advanced test, there were three other block-assembly kits used in the combined array for the advanced test. See Figure 11 for the nature of the combined array and Figures 7, 8, and 9 for the three separate problems that comprised the array. Figure 10 shows the variations in the center

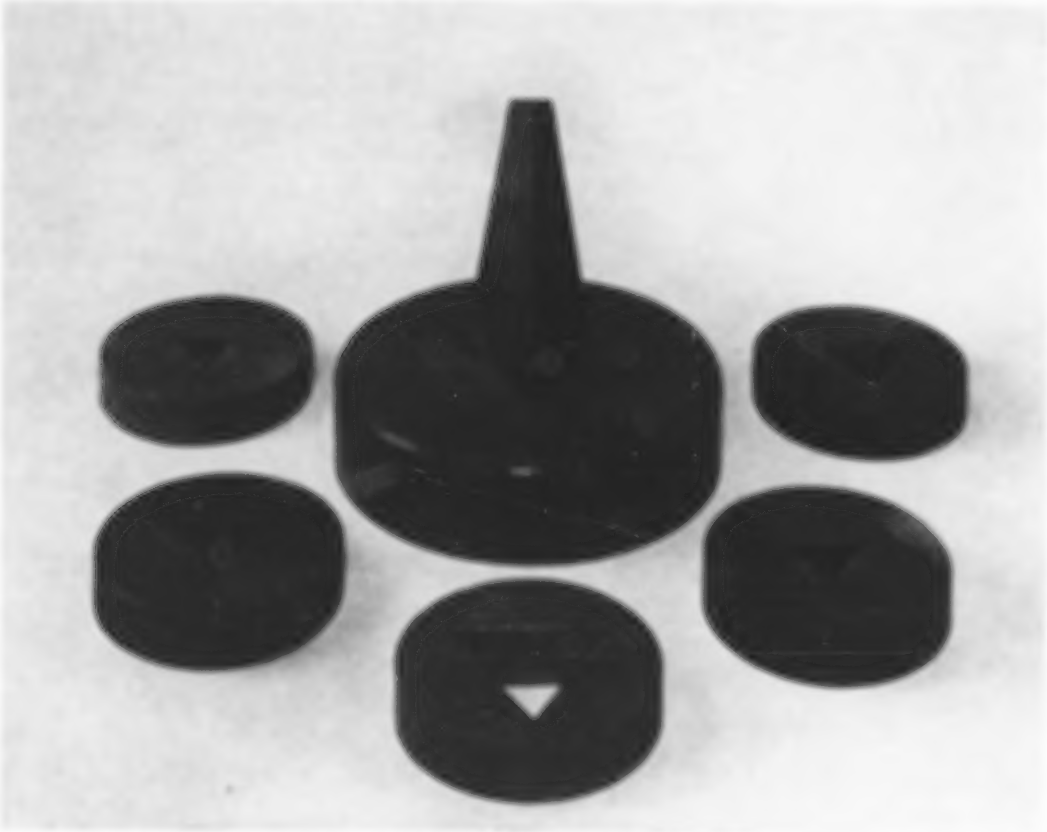

Figure 7. PRESENTATION ARRAY 7

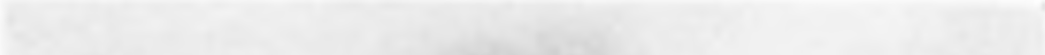

Figure 8. PRESENTATION ARRAY 8

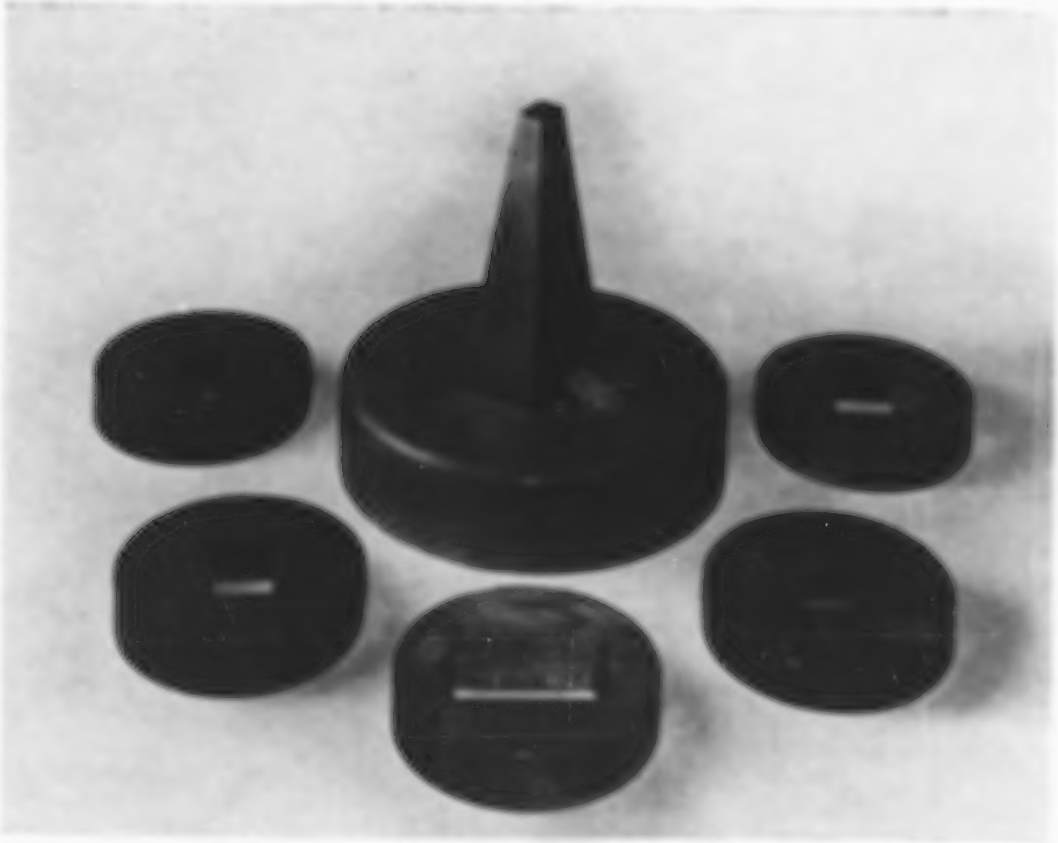

Figure 9. PRESENTATION ARRAY 9

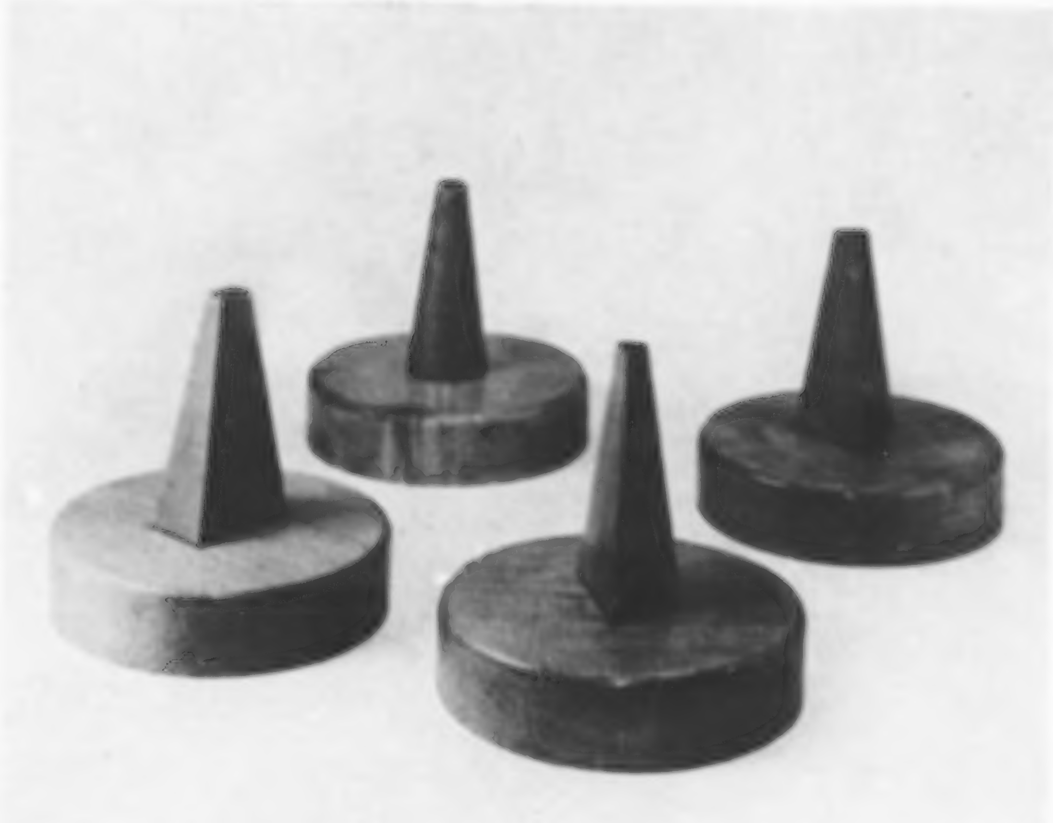

Figure 10. VARIATIONS IN CENTER POSTS

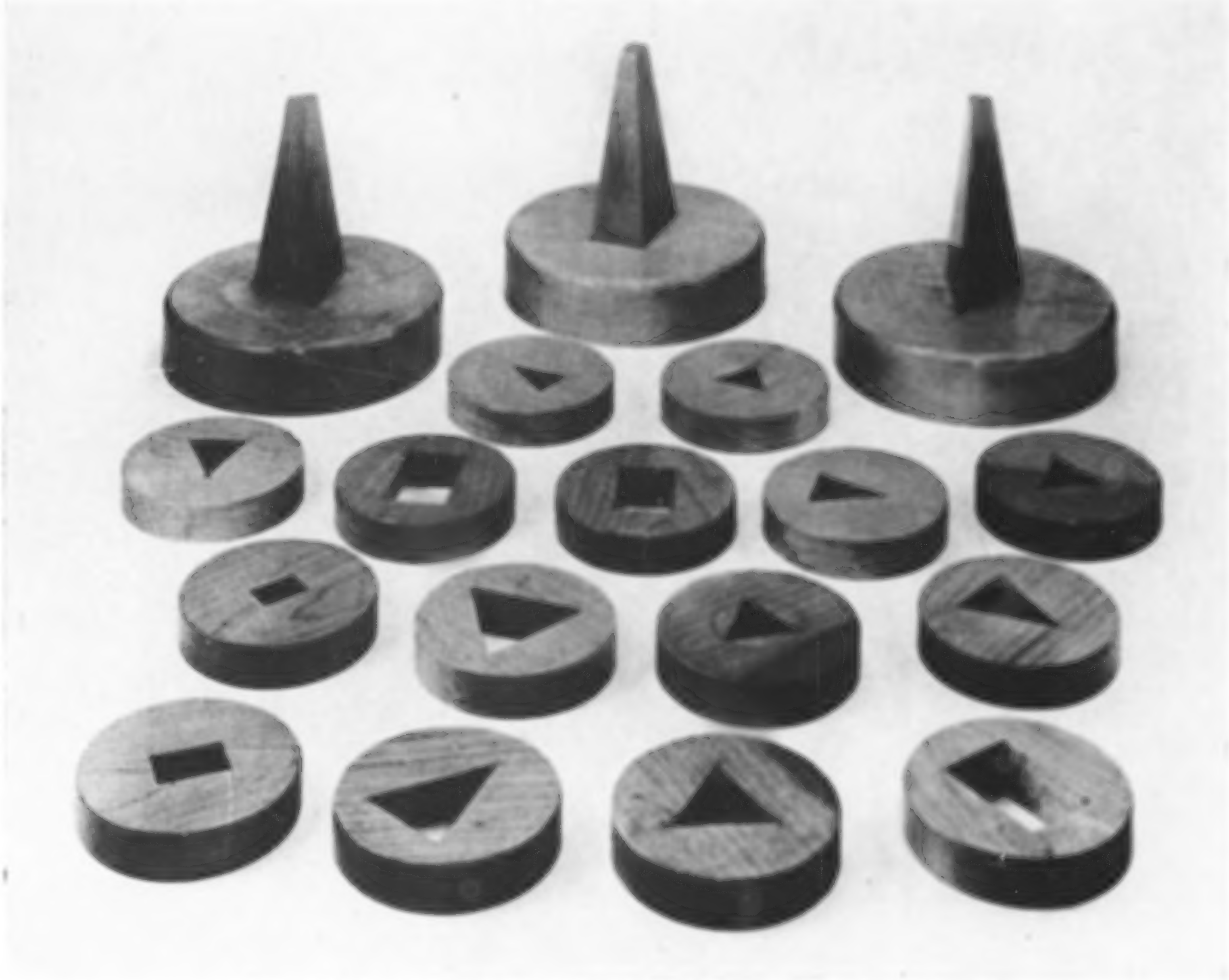

Figure 11. PRESENTATION ARRAY FOR ADVANCED TEST

posts of these three problems in comparison with the conical type used in the six pre-training problems. Such variations placed further restrictions on the nature of a correct response, e.g., correct alignment of each block, and rendered even more remote the probability of chance success.

The recording apparatus was a polygraph driven by a synchronous electric motor. The constant speed drive provided an automatic record, via an appropriate switch, of the amount of time in seconds consumed by each subject for each component of each problem. Multiple records of other response measures were also provided when the experimenter depressed one or more push-button switches according to plan. For example, depressing a given switch momentarily indicated that a response had been made, i.e., a block had been tried on the post with or without success; depressing another given switch at the same time recorded a correct response. The time to the nearest second for each correct response provided the most sensitive and revealing data for the statistical analysis that followed. Error data were also available for study.

Procedures:

The procedure for administering the problem solving tests was briefly as follows:

A subject was seated at a table. The experimenter arranged presentation array 1 behind a cardboard screen.

Timing started when the experimenter exposed the array to the subject's view. Both pantomime and oral directions were used to convey the message that the blocks should be assembled on the post. A few motions were usually sufficient to put the subject in action trying to fit the blocks on the post. When problem 1 was completed, the next array was prepared as before, and this routine continued through all six problems.

The subject was not told whether any response was right or wrong. If any incorrect arrangements were left on the center post by the subject, it became impossible to fit all the blocks on the post; and this led the subject eventually to remove them and start again. For purposes of recording responses, the following working rules were formulated (83):

(a) A response was defined as an overt attempt to fit a block on the center post.

(b) A response was recorded at the instant of contact between block and post.

(c) A response was judged correct if it satisfied the following conditions: (1) if the block or blocks, if any, that should precede it was already properly in place on the post, (2) if the block was turned right side up, (3) if a block was fitted in its proper place on the center post, and (4) if the block was allowed to remain in proper position.

(d) A response was counted an error if one or more of the above four conditions was violated. (The assembled problems are shown in Figures 12-17).

Upon completion of the six main problems, the subject was presented the combined array (Figure 11) of the advanced test and directed to assemble all three component problems simultaneously. If a given subject made no progress in 180 seconds, the experimenter stopped the test and then presented separately the three problems (Figures 7, 8, 9) that had comprised the combined array. If the subject was able to solve each problem separately, he was given another opportunity to solve the advanced test. A time limit of 300 seconds was placed on this final effort. The results enabled the investigator to select 15 successful and 15 unsuccessful individuals for each main sample of mentally retarded subjects. A balanced factorial design facilitated the programming of analysis of variance in the IBM 650 Computer (16). The complete analysis of variance of the "time" data and of the "errors" data was also calculated by means of a desk-model electric calculator as a check on statistical accuracy.

Results

The results of the several analyses of variance of the "time" data are presented in a series of tables summarizing the calculations. The separate analyses by sub-groups of subjects are presented in Tables 3.1, 4.1, 5.1, and 6.1 to enable the investigator to assess the relative group contributions to each main effect and interaction in the complete

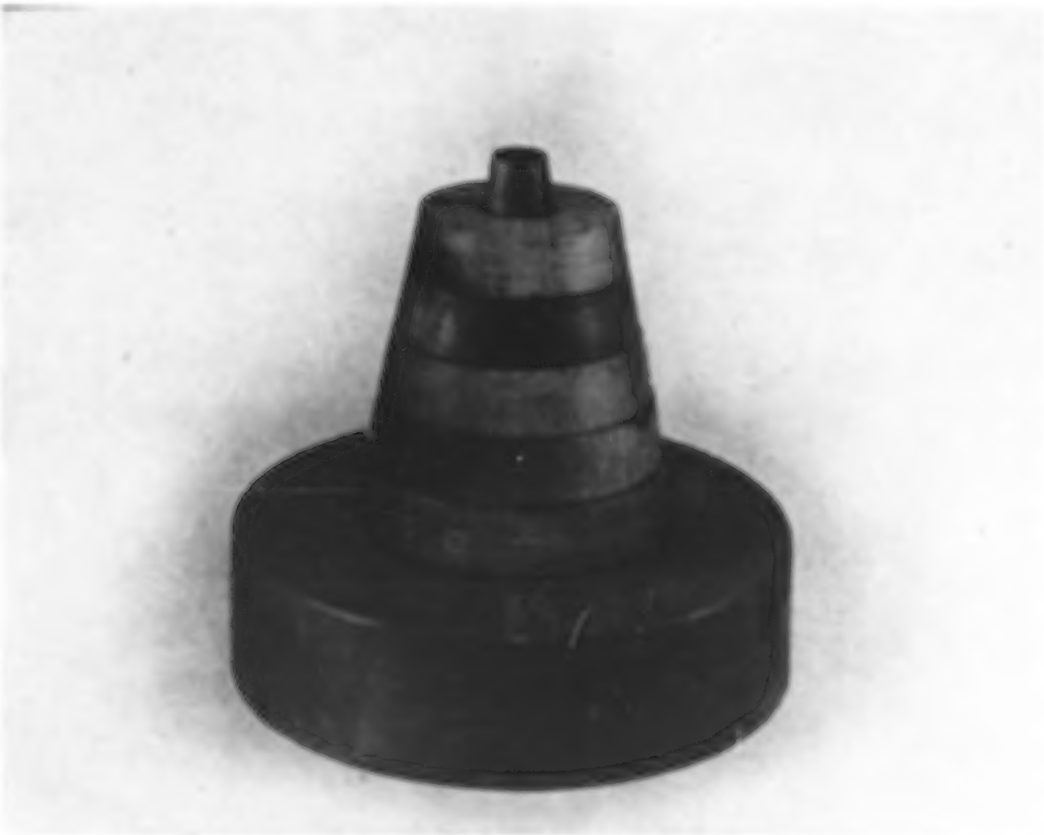

Figure 12. ASSEMBLED PROBLEM 1

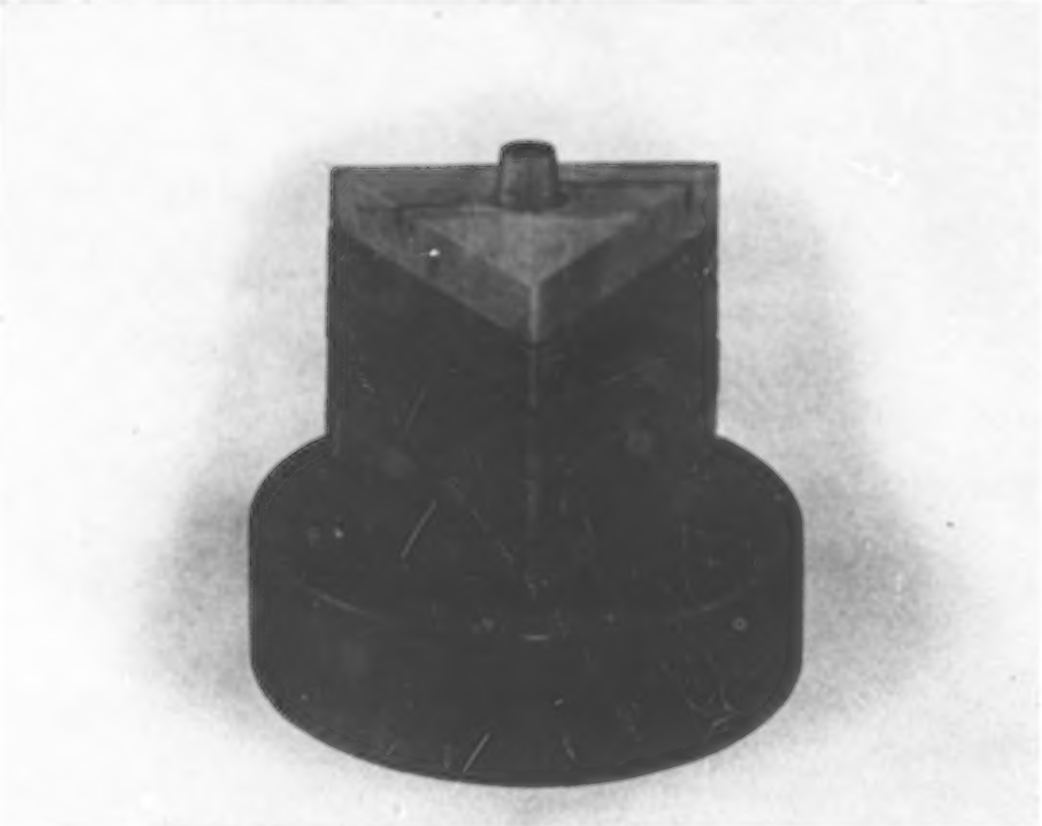

Figure 13. ASSEMBLED PROBLEM 2

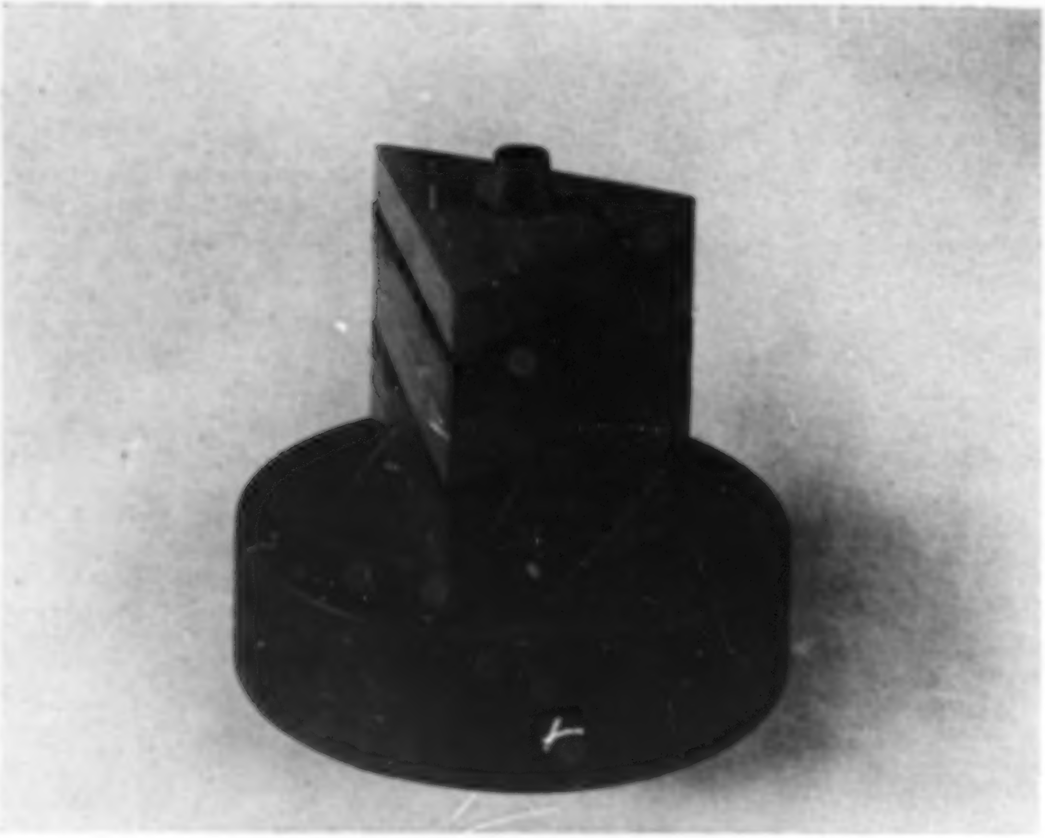

Figure 14. ASSEMBLED PROBLEM 3

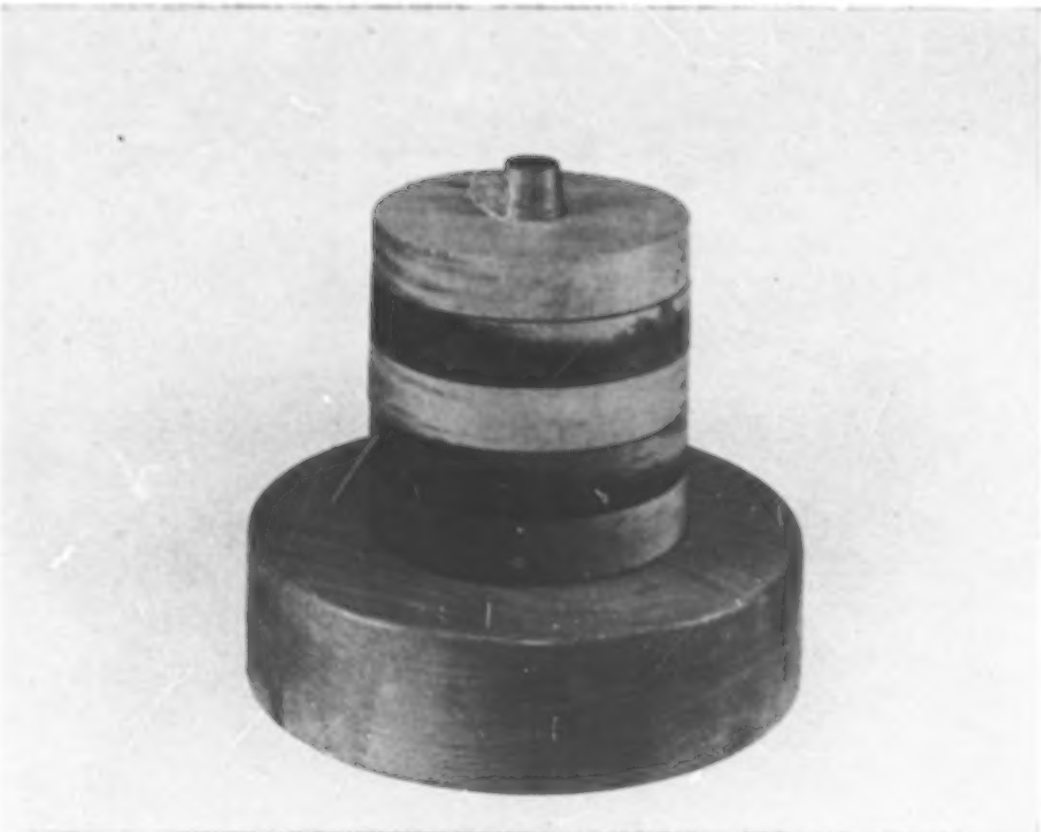

Figure 15. ASSEMBLED PROBLEM 4

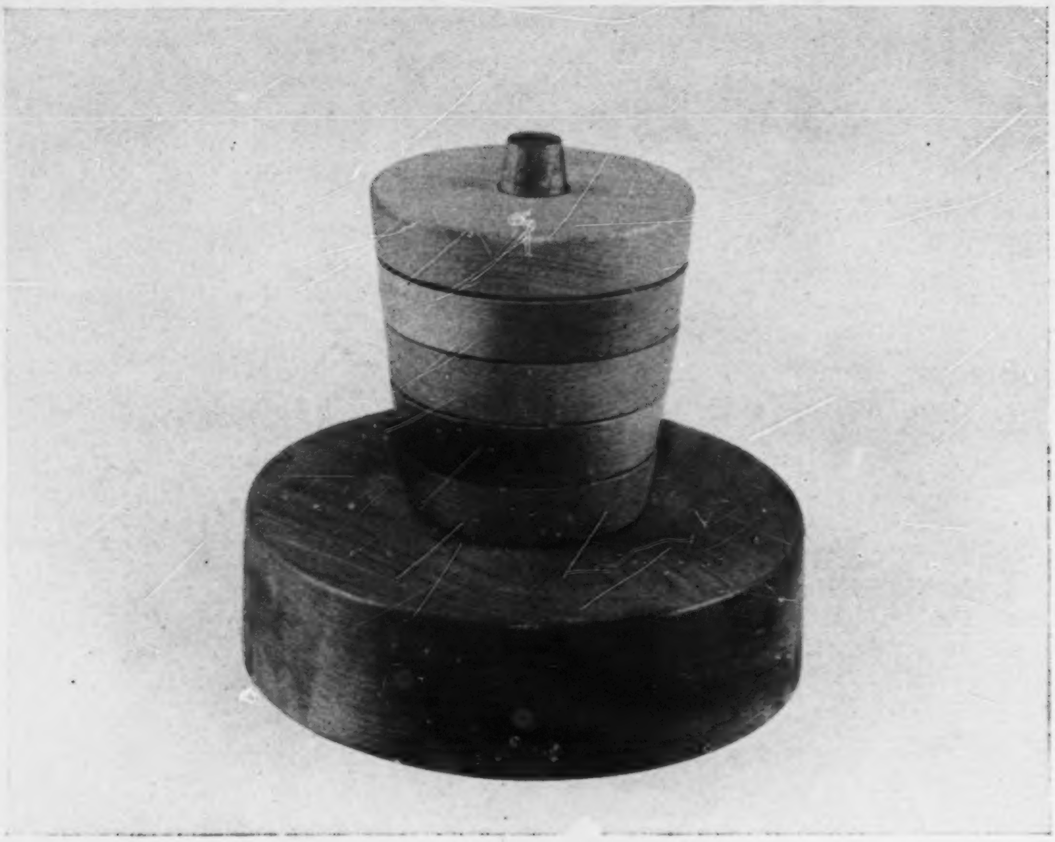

Figure 16. ASSEMBLED PROBLEM 5

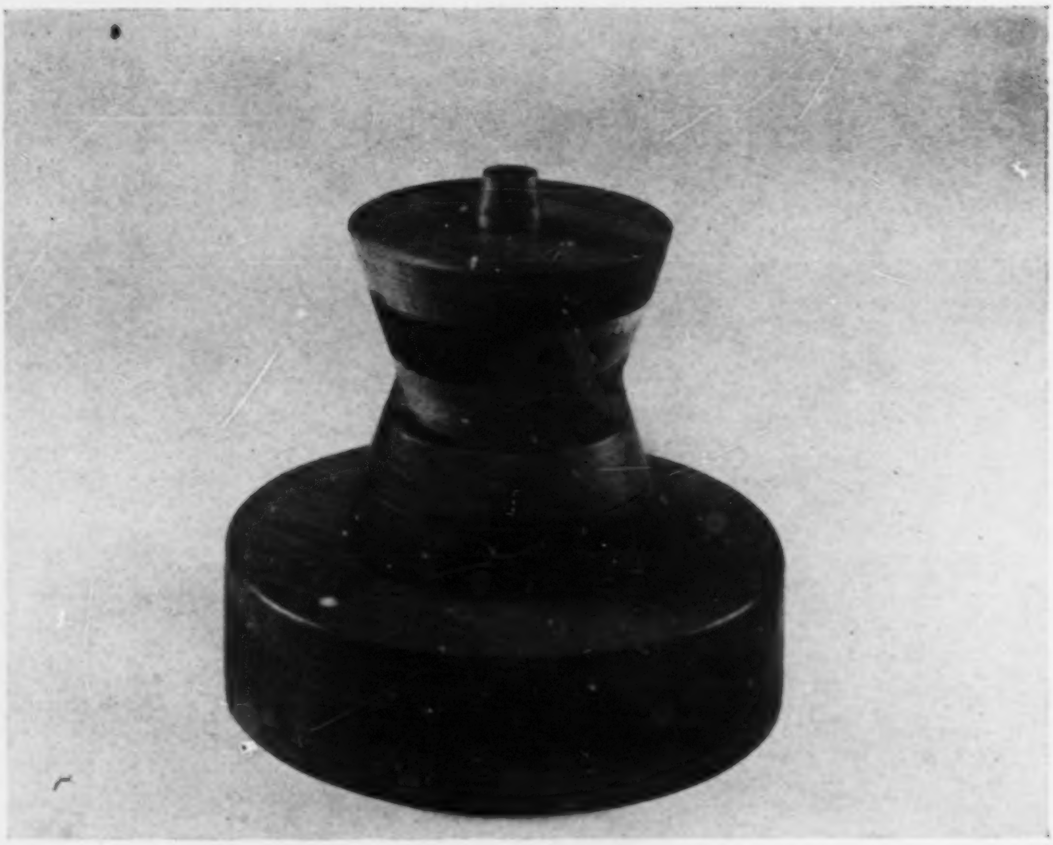

Figure 17. ASSEMBLED PROBLEM 6

Table 3.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the High-Achievement Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	6341	14	453		
k	2430	4	608	5.11	.01
j	3179	5	636	7.57	.01
ik	6641	56	119	1.35	
ij	5893	70	84	0.96	
jk	7995	20	400	4.55	.01
ijk	24603	280	88		
Total	57082	449			

* Probability is indicated only where F is considered significant.

Table 4.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Low-Achievement Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	11413	14	815		
k	7979	4	1995	11.47	.01
j	4847	5	969	6.38	.01
ik	9730	56	174	1.55	.05
ij	10631	70	152	1.35	
jk	8894	20	445	3.96	.01
ijk	31426	280	112		
Total	84920	449			

* Probability is indicated only where F is considered significant.

Table 5.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the High-Achievement Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	10668	14	762		
k	4622	4	1156	12.57	.01
j	5432	5	1086	8.62	.01
ik	5175	56	92	0.89	
ij	8844	70	126	1.22	
jk	7512	20	376	3.64	.01
ijk	28934	280	103		
Total	71187	449			

* Probability is indicated only where F is considered significant.

Table 6.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Low-Achievement Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	7896	14	564		
k	20082	4	5021	38.04	.01
j	7574	5	1515	6.59	.01
ik	7382	56	132	0.89	
ij	16109	70	230	1.55	.05
jk	9623	20	481	4.26	.01
ijk	41500	280	148		
Total	100166	449			

* Probability is indicated only where F is considered significant.

analysis. Tables 7.1 and 7.2 present the complete analysis of variance for the entire factorial design shown in Table 2.6. Where significant main effects and interactions were found, graphic or tabular presentations of the magnitude of those effects and interaction residuals are also included immediately following the aforementioned tables.

In order to assess the relationship between the Stanford-Binet IQ scores for these subjects and their performance characteristics on the block-assembly problems, an appropriate grouping of the subjects into three groups of 10 individuals each for each main sample was made. With the data arranged accordingly, separate analyses of variance of the data for each of the six groups were calculated. The results are summarized in Tables 8.1, 9.1, 10.1, 11.1, 12.1, and 13.1.

Discussion

Hypothesis 1.

A significant inter-group variability in problem-solving performance was clearly shown. See factor "g" in Table 7.1.

Greater general developmental maturity did give these mentally retarded individuals a significant advantage on these tasks over more immature individuals even though the latter had somewhat higher IQ scores. What specific maturational factors were predominant in producing this advantage was not determined by this experimental design.

Table 7.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
k	26161	4	6540	50.70	.01
j	18643	5	3729	25.20	.01
h	11615	1	11615	17.90	.01
g	11149	1	11149	17.18	.01
jk	26974	20	1349	11.94	.01
hk	4725	4	1181	9.16	.01
gk	3231	4	808	6.26	.01
hj	356	5	71	0.48	
gj	1022	5	204	1.38	
hg	7	1	7	0.01	

* Probability is indicated only where F is considered significant.

Table 7.2 Continued Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
hjk	1387	20	69	0.61	
gjk	1999	20	99	0.88	
ghk	997	4	249	1.93	
ghj	1011	5	202	1.37	
ghjk	3665	20	183	1.62	.05
i	36318	56	649		
ik	28928	224	129	1.14	
ij	41477	280	148	1.31	.01
ijk	126463	1120	113		
Total	346128	1799			

* Probability is indicated only where F is considered significant.

Table 7.3 The First-Order Interaction Residuals of the Six Block-Assembly Problems and the Five Component Parts of Each Problem for the Total Sample of Mentally Retarded Subjects.

Problem	Component 1	2	3	4	5
1	+ 254	+ 15	- 112	- 83	- 70
2	- 29	+ 111	+ 63	- 74	- 64
3	- 120	+ 36	+ 3	+ 30	+ 56
4	- 247	- 32	+ 137	+ 75	+ 73
5	+ 339	- 62	- 92	- 99	- 81
6	- 189	- 61	+ 7	+ 159	+ 92

A positive sign indicates that an idiosyncratic increment in response time occurred.

Table 7.4 The First-Order Interaction Residuals of the Six Block-Assembly Problems with the Fifteen Organisms in the Low-Achievement Group at Madison.

Subjects	Problems					
	1	2	3	4	5	6
BFAY	+ 142	- 257	- 9	+ 126	- 177	+ 176
BIAY	+ 241	- 91	- 107	- 161	- 131	+ 249
BMAY	- 149	+ 316	+ 259	- 44	+ 42	- 423*
BNAY	+ 159	+ 22	+ 17	- 205	- 62	+ 69
BOBY	+ 170	+ 26	- 345	+ 74	- 112	+ 187
BRBY	+ 42	- 45	- 220	+ 139	+ 66	+ 19
BUBY	+ 381	- 131	+ 83	- 31	- 190	- 112
BXBY	- 193	+ 174	+ 148	- 525*	+ 406*	- 11
BYCY	+ 249	+ 10	- 75	- 58	- 93	- 33
BZCY	- 397	+ 281	+ 71	- 62	+ 199	- 93
CBCY	- 219	+ 86	+ 90	+ 225	+ 193	- 375
CDCY	- 5	- 169	+ 166	+ 254	- 63	- 183
CECY	- 418*	- 143	+ 149	+ 98	+ 124	+ 190
CGCY	- 171	- 106	+ 117	+ 95	- 91	+ 155
CHCY	+ 170	+ 26	- 345	+ 74	- 112	+ 187

* The largest residuals indicate highly significant idiosyncracies. A positive sign indicates that an increment in response time has occurred.

Table 7.5 The First-Order Interaction Residuals of the Fifteen Organisms with the Five Component Parts of the Problems in the Low-Achievement Group at Southern Colony.

Subjects	Components				
	1	2	3	4	5
AAAY	+ 184	0	- 190	+ 23	- 56
AGAY	+ 85	- 43	+ 137	- 117	- 100
AJAY	+ 128	- 292	+ 79	- 15	+ 61
AKBY	- 229	- 33	+ 113	+ 115	- 3
ANBY	- 163	- 73	+ 42	+ 96	+ 59
AOBY	+ 255	- 47	- 218	- 89	+ 59
APBY	+ 15	+ 509*	- 117	- 202	- 243
ASBY	- 34	+ 56	- 10	+ 32	- 81
ATBY	+ 25	- 127	- 8	- 25	+ 97
AUCY	+ 181	- 13	- 31	- 111	- 66
AVCY	+ 399*	- 81	- 174	- 133	- 48
AWCY	- 36	+ 105	+ 328	+ 88	+ 67
AXCY	- 146	+ 115	- 13	+ 103	- 97
BBCY	- 407*	- 23	+ 95	+ 119	+ 179
BDCY	- 255	- 45	- 26	+ 116	+ 174

* The largest residuals indicate highly significant idiosyncracies. A positive sign indicates that an increment in response time occurred.

Table 8.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the High-Mental-Age Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	3248	9	361		
k	1618	4	405	4.01	.01
j	2007	5	401	3.29	.05
ik	3625	36	101	1.12	
ij	5488	45	122	1.36	
jk	6240	20	312	3.47	.01
ijk	16140	180	90		
Total	38366	299			

* Probability is indicated only where F is considered significant.

Table 9.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Middle-Mental-Age Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	12730	9	1414		
k	5114	4	1279	6.24	.01
j	4402	5	880	7.22	.01
ik	7390	36	205	1.67	.05
ij	5471	45	122	0.99	
jk	4931	20	247	2.01	.01
ijk	22130	180	123		
Total	62168	299			

* Probability is indicated only where F is considered significant.

Table 10.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Low-Mental-Age Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	8291	9	921		
k	3878	4	970	5.84	.01
j	2073	5	415	4.32	.01
ik	5964	36	166	1.91	.01
ij	4315	45	96	1.10	
jk	7287	20	364	4.18	.01
ijk	15686	180	87		
Total	47494	299			

* Probability is indicated only where F is considered significant.

Table 11.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the High-Mental-Age Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	4775	9	531		
k	6802	4	1701	12.24	.01
j	3381	5	676	5.49	.01
ik	5002	36	139	1.12	
ij	5530	45	123	0.99	
jk	8922	20	446	3.60	.01
ijk	22308	180	124		
Total	56720	299			

* Probability is indicated only where F is considered significant.

Table 12.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Middle-Mental-Age Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	6770	9	752		
k	4685	4	1171	8.31	.01
j	6575	5	1315	8.71	.01
ik	5060	36	141	1.26	
ij	6784	45	151	1.35	
jk	4384	20	219	1.96	.05
ijk	20191	180	112		
Total	54449	299			

* Probability is indicated only where F is considered significant.

Table 13.1 Summary of the Analysis of Variance of the Data on the Block-Assembly Problem Solving Behavior of the Low-Mental-Age Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	6216	9	691		
k	10181	4	2545	16.42	.01
j	4111	5	822	3.21	.05
ik	5573	36	155	1.09	
ij	11536	45	256	1.80	.01
jk	5940	20	297	2.09	.01
ijk	25512	180	142		
Total	69068	299			

* Probability is indicated only where F is considered significant.

Another type of significant inter-group variability was also found. See factor "h" in Table 7.1.

Grouping of the subjects by achievement or non-achievement on the advanced test produced as great an effect in this analysis of the pre-training data as the effect of general developmental maturity. (See Figure 18.)

Such achievement grouping produced a clear-cut alignment of relevant developmental factors for performing these tasks most efficiently. The nature of these factors became clearer in the significant inter-group by intra-problem interactions to be discussed in connection with hypothesis 5.

Developmental maturity was an important intervening variable to be reckoned with in the problem-solving behavior of the mentally retarded under the conditions of this experiment. Even though the upper ranges of such development may be seriously truncated, significant variability remained. While this might seem to be an elaboration of the obvious, the matter of delimiting the nature of the effects of developmental maturity on learning in mental retardation did not seem obvious at all in these experiments, as a comparison of the results of the second experiment will demonstrate.

Developmental maturity for a mentally retarded individual must carry many differential implications depending both upon the nature of the neuro-physiological impairment and upon the nature of the problem-solving situation. Many of the subjects in this experiment were recorded as having suffered unspecified

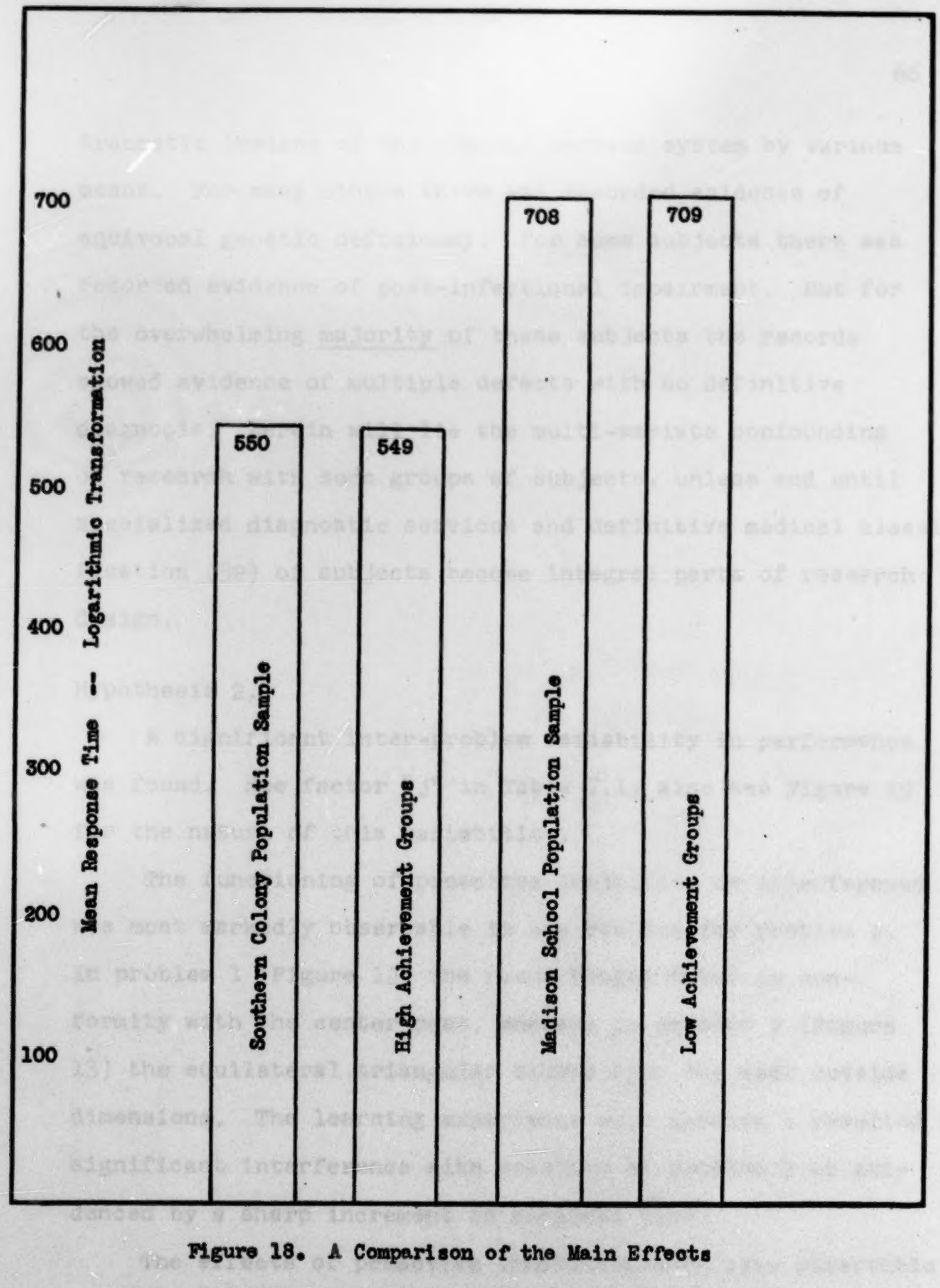

Figure 18. A Comparison of the Main Effects of Two Population Samples with Two Achievement Sub-Groups

(550 = 0.550 log seconds)

traumatic lesions of the central nervous system by various means. For many others there was recorded evidence of equivocal genetic deficiency. For some subjects there was recorded evidence of post-infectional impairment. But for the overwhelming *majority* of these subjects the records showed evidence of multiple defects with no definitive diagnosis. Herein will lie the multi-variate confounding of research with such groups of subjects, unless and until specialized diagnostic services and definitive medical classification (52) of subjects become integral parts of research design.

Hypothesis 2.

A significant inter-problem variability in performance was found. See factor "J" in Table 7.1; also see Figure 19 for the nature of this variability.

The functioning of proactive inhibition or interference was most markedly observable in the results for problem 2. In problem 1 (Figure 12) the round blocks taper in conformity with the center post, whereas in problem 2 (Figure 13) the equilateral triangular blocks have the same outside dimensions. The learning experience with problem 1 resulted in significant interference with solution of problem 2 as evidenced by a sharp increment in response time.

The effects of proactive inhibition were also observable in significant proportions in problems 3, 5, and 6 although

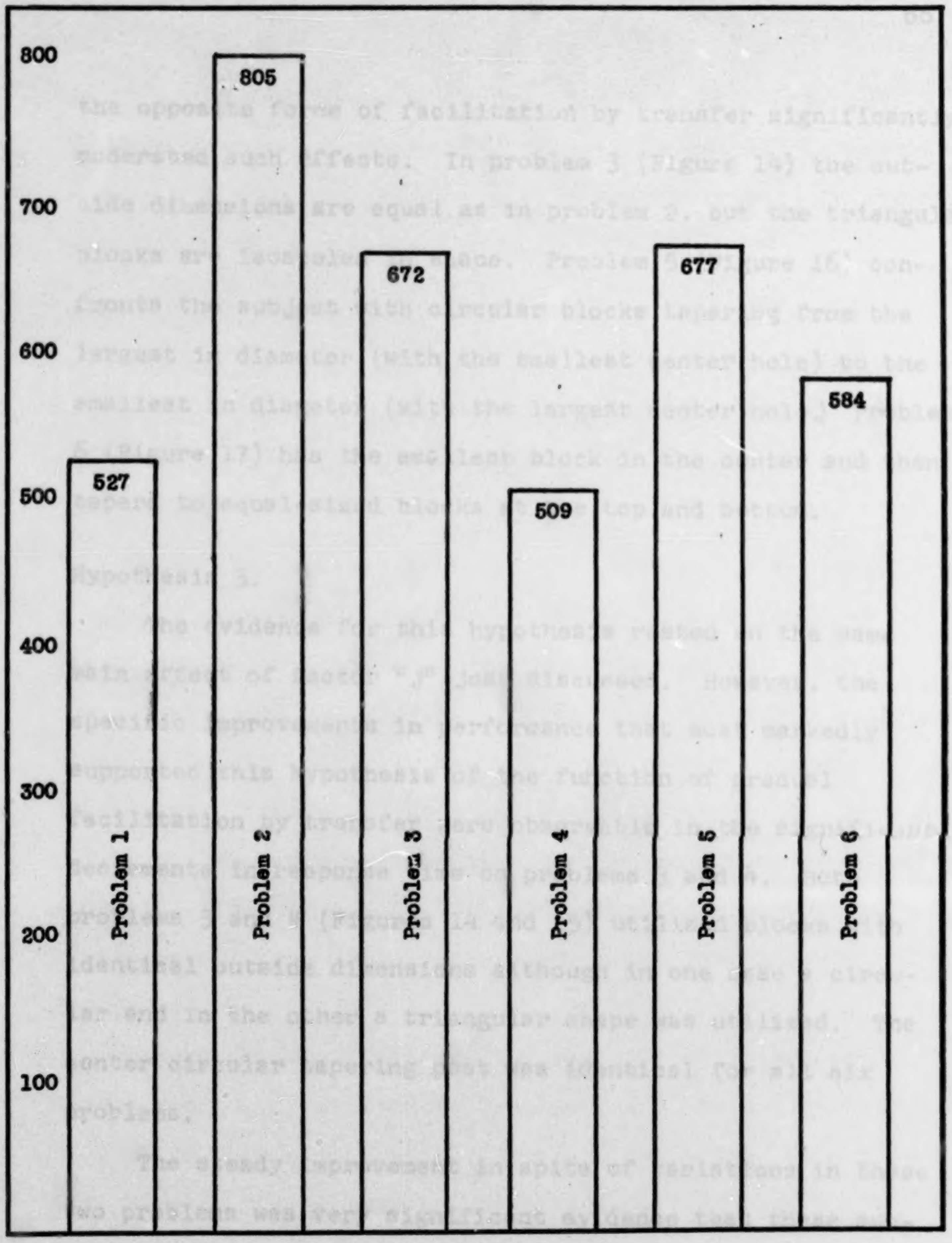

Figure 19. The Main Effects of the Six Block-Assembly Problems

the opposite force of facilitation by transfer significantly moderated such effects. In problem 3 (Figure 14) the outside dimensions are equal as in problem 2, but the triangular blocks are isosceles in shape. Problem 5 (Figure 16) confronts the subject with circular blocks tapering from the largest in diameter (with the smallest center hole) to the smallest in diameter (with the largest center hole.) Problem 6 (Figure 17) has the smallest block in the center and then tapers to equal-sized blocks at the top and bottom.

Hypothesis 3.

The evidence for this hypothesis rested on the same main effect of factor "j" just discussed. However, the specific improvements in performance that most markedly supported this hypothesis of the function of gradual facilitation by transfer were observable in the significant decrements in response time on problems 3 and 4. Both problems 3 and 4 (Figures 14 and 15) utilized blocks with identical outside dimensions although in one case a circular and in the other a triangular shape was utilized. The center circular tapering post was identical for all six problems.

The steady improvement in spite of variations in these two problems was very significant evidence that these subjects could transfer some learning on such tasks. Although the trend was obscured by an overwhelming interference on the next problem, there was a vigorous resumption of the trend on the last problem. The moderation in rate of improvement on the last problem may be more appropriately considered in relation to hypothesis 7.

Hypothesis 4.

The most significant main effect in the entire factorial design was found in intraproblem variability. See factor "k" in Table 7.1; see also Figure 20 for the nature of this variability.

While the increasing probability of correct assembly purely by chance was inherent in the problem design, its magnitude was negligible as previously described. However, the potential maximum errors necessary to discover the correct assembly solely by trial-and-error elimination decreased from nine on the first block to 1 on the last block. This nine-fold range in maximum elimination errors compared very discrepantly with the almost two-fold range in response time, nearly half of the latter occurring on the last block. (See Figure 20).

A very important intervening variable of organismic nature seemed now exposed to examination. As a given subject progressed through the assembly of the components of a problem, he wittingly or unwittingly found that the design of the problem steadily forced the convergence of his attention upon the dwindling remainder of blocks. This convergence yielded increased attention to relevant cues.

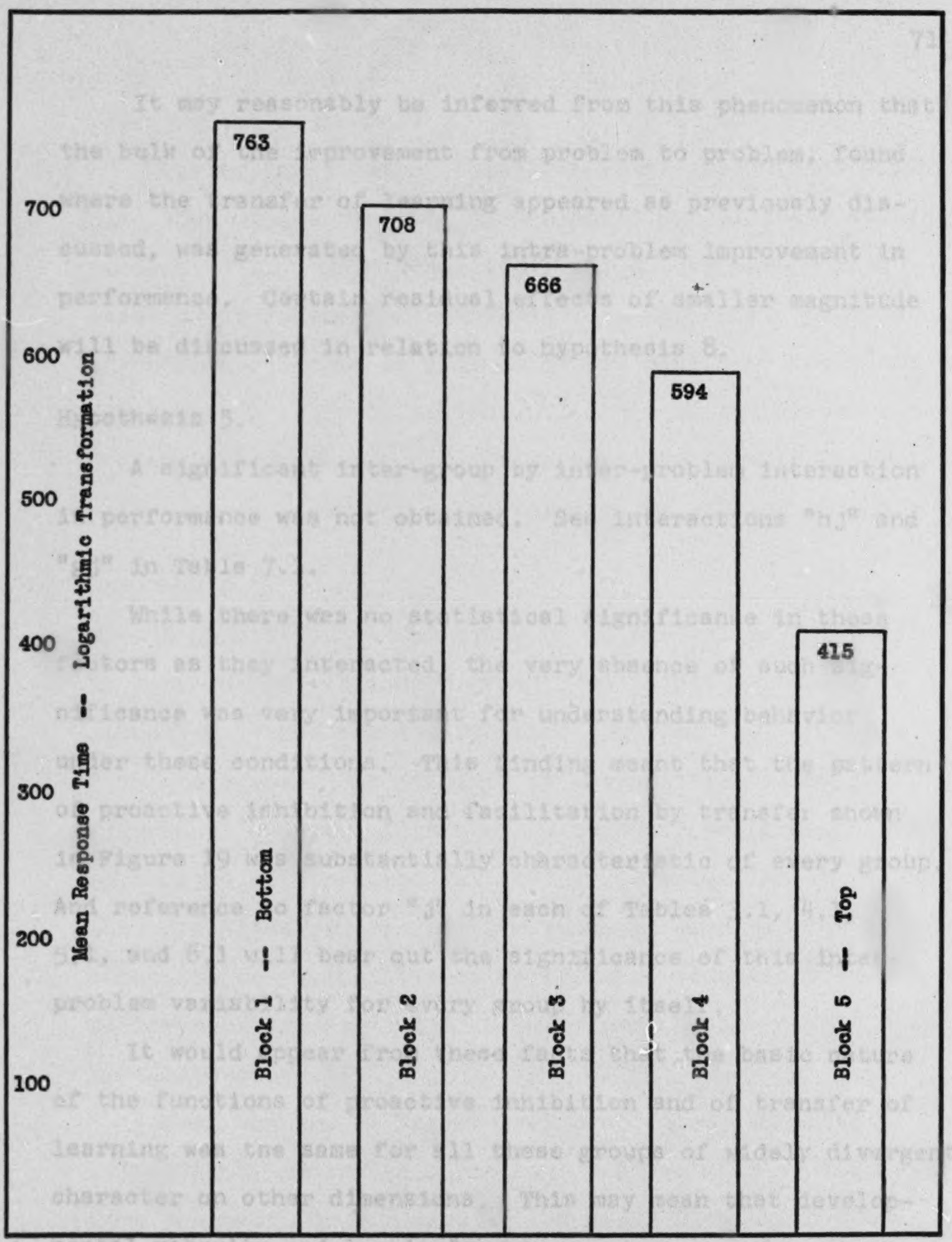

Figure 20. The Main Effects of the Five Component Parts of the Problems

It may reasonably be inferred from this phenomenon that the bulk of the improvement from problem to problem, found where the transfer of learning appeared as previously discussed, was generated by this intra-problem improvement in performance. Certain residual effects of smaller magnitude will be discussed in relation to hypothesis 8.

Hypothesis 5.

A significant inter-group by inter-problem interaction in performance was not obtained. See interactions "hj" and "gj" in Table 7.1.

While there was no statistical significance in these factors as they interacted, the very absence of such significance was very important for understanding behavior under these conditions. This finding meant that the pattern of proactive inhibition and facilitation by transfer shown in Figure 19 was substantially characteristic of every group. And reference to factor "j" in each of Tables 3.1, 4.1, 5.1, and 6.1 will bear out the significance of this inter-problem variability for every group by itself.

It would appear from these facts that the basic nature of the functions of proactive inhibition and of transfer of learning was the same for all these groups of widely divergent character on other dimensions. This may mean that developmental maturity and level of achievement are, within terminal structural limits of course, quite irrelevant in so far as the basic functions of proactive inhibition and transfer of learning are concerned.

Taking these latter functions as reciprocals on a single dimension of learning and taking advantage of their stable predictability, within necessary limits, by having them serve as an independent variable in a research design, an investigator should be able to expose many more important contrasts in cue utilization in learning. Under such conditions subjects need only be screened to be sure their impairments do not preclude performance on given problems.

Hypothesis 6.

A significant inter-group by intra-problem interaction in performance was indeed discovered in both grouping dimensions. See the interactions "gk" and "hk" in Table 7.1; and compare the patterns of these interactions in Figures 21 and 22. Note how the superior performance was associated with reduced variability in attention to relevant cues, as discussed in relation to hypothesis 4. The greatest reduction in variability of performance time was produced by achievement grouping, i.e., in the performance of the high groups combined.

Even though, as has already been noted, the basic functions of proactive inhibition and transfer of learning were the same for all groups, the speed with which these groups functioned and utilized the relevant cues was very definitely related to developmental maturity and achievement level. Increased speed of identifying and reacting to

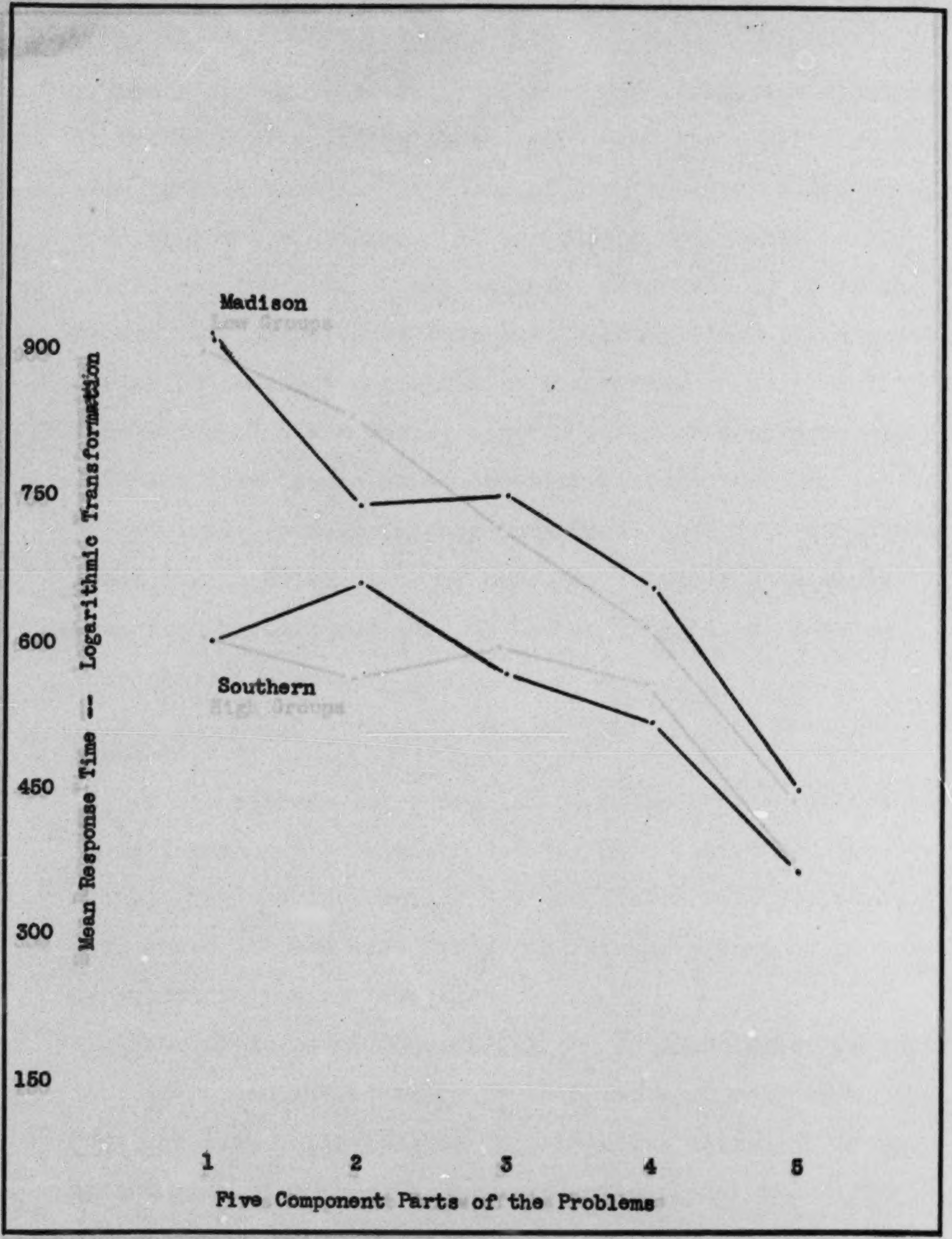

Figure 21. The Interaction of the Two Population Samples and the Five Component Parts of the Problems

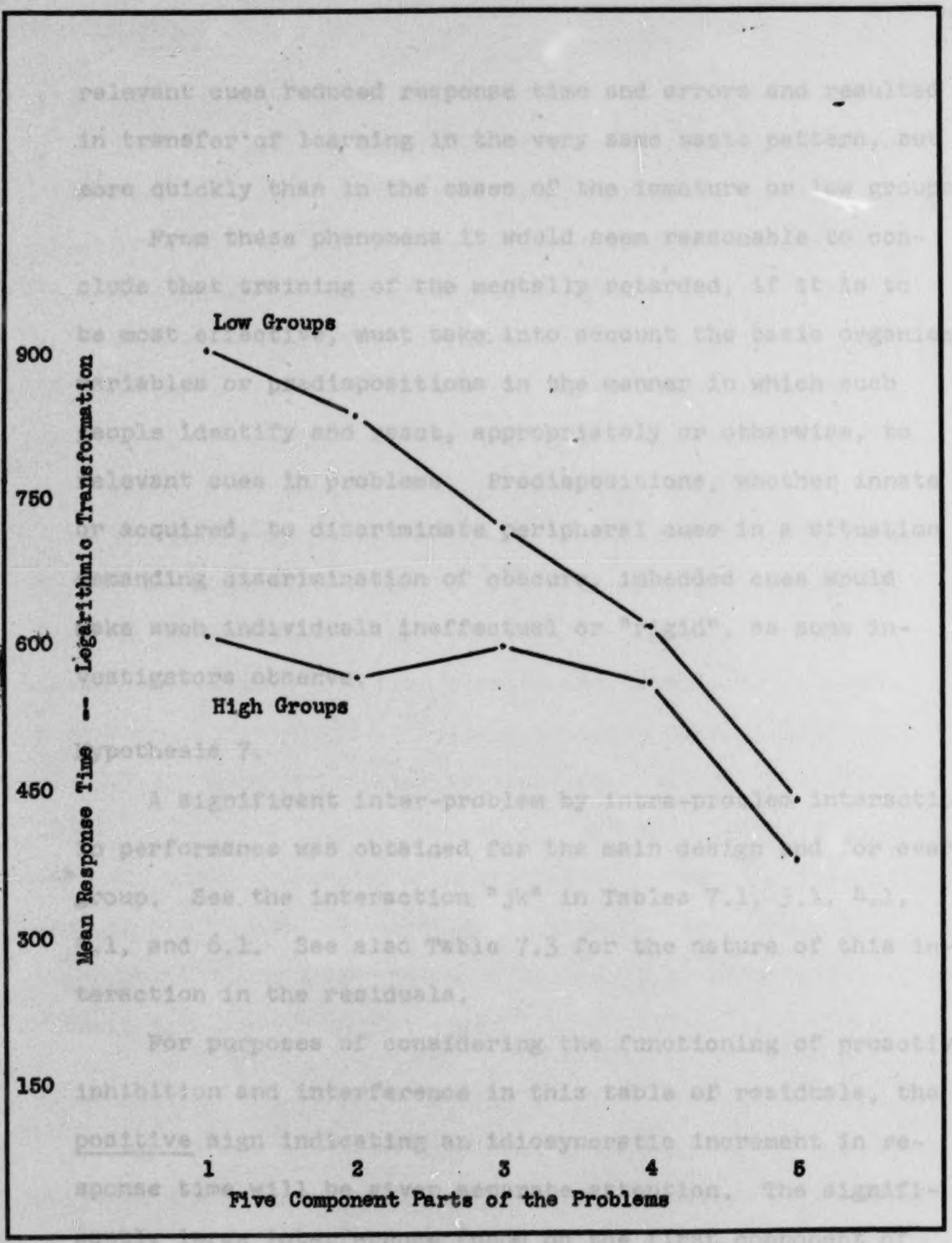

Figure 22. The Interaction of the Two Achievement Groups and the Five Component Parts of the Problems

relevant cues reduced response time and errors and resulted in transfer of learning in the very same basic pattern, but more quickly than in the cases of the immature or low groups.

From these phenomena it would seem reasonable to conclude that training of the mentally retarded, if it is to be most effective, must take into account the basic organismic variables or predispositions in the manner in which such people identify and react, appropriately or otherwise, to relevant cues in problems. Predispositions, whether innate or acquired, to discriminate peripheral cues in a situation demanding discrimination of obscure, imbedded cues would make such individuals ineffectual or "rigid", as some investigators observe.

Hypothesis 7.

A significant inter-problem by intra-problem interaction in performance was obtained for the main design and for every group. See the interaction "jk" in Tables 7.1, 3.1, 4.1, 5.1, and 6.1. See also Table 7.3 for the nature of this interaction in the residuals.

For purposes of considering the functioning of proactive inhibition and interference in this table of residuals, the positive sign indicating an idiosyncratic increment in response time will be given separate attention. The significantly large interference found on the first component of problem 1 indicated that past experience brought to this task was not helpful. The interference on the second component of problem 2 indicated that the learning transferred from problem 1 as a function of peripheral cues (sloping exterior design -- see Figure 12) impeded the solution of problem 2 which did not have a sloping exterior contour. This very same type of interference occurred again on the third component of problem 4 which had a round shape reinforcing the memory of problem 1 (compare Figures 12 and 15), but lacked the expected sloping contour.

The most significant residual of all and the most severe proactive inhibition occurred on component 1 of problem 5. See the peripheral cues in problem 5 in Figure 16. Very great interference resulted because the peripheral contour cues were now reversed in value from those of the first problem. The subjects strongly resisted putting the smallest block on the post first, instead of last as originally learned.

The final important demonstration of proactive inhibition came on the fourth component of problem 6. See Figure 17 to appreciate the fundamental relationship between this interference and the peripheral cues.

Hypothesis 8.

The same interaction discussed in the preceding hypothesis provided the test of the function of facilitation by transfer at uniquely revealing stages of performance.

By reference again to Table 7.3 and to the negative signs indicating a decrement in response time, the points at which marked improvement in performance and increased transfer of learning occurred are clearly revealed. The first great improvement took place on component 3 of problem 1 where the tapering contour of the problem design was very obvious. (See Figure 12.) But, very significantly, this particular learning served thereafter as the basic element in the function of proactive inhibition or interference.

All other unique demonstrations of improvement in performance and transfer of learning occurred on the first component only of several problems, viz., numbers 3, 4, and 6. When the original learning based on peripheral cues became an interference on the second problem, the subjects were motivated to make a different discrimination of cues in the situation and managed to make the significant discrimination of first using the block with the largest hole in it. This discrimination was reinforced in problem 4 and managed to survive the interference on problem 5 to reappear on problem 6 only slightly weakened in significance.

The two different attention sets formed by these subjects, one based on peripheral contour cues and the other based on size cues in the center hole, were placed in diametric opposition on component 1 of problem 5. The resulting magnitude of interference was revealing of the scanty quality of the cues utilized in the formation of these attention sets. It was also indicative of the lack of utilization of the helpful inter-relationships among several relevant cues to form an effective learning set to replace the competing attention sets.

The absence or weakness of the function of abstracting relationships from cues in a problem situation is investigated more intensively in the second experiment. The absence of abstraction of relationships from cues was confirmed on problem 6 of this first experiment when both crude attention sets reappeared operating at a very significant level in reciprocal fashion. See components 1 and 4 of problem 6 in Table 7.3.

Hypothesis 9.

Significant individual idiosyncracies in inter-problem variability in performance were found to be characteristic of the entire population studied. See interaction "ij" in Table 7.2.

An examination of Tables 3.1, 4.1, 5.1, and 6.1 reveals that the low achievement group of Madison contributed most to this significance. See the interaction residuals in Table 7.4 for the nature of these idiosyncracies. Subject BMAY demonstrated highly significant progress on problem 6, perhaps indicating that this individual momentarily, at least, learned to attend to the relevant cues and may be even the inter-relationships among cues to a limited but helpful degree. If so, this was a fleeting enlightenment, for these subjects in the low groups failed the advanced test immediately after problem 6.

Subject BMAY has been the victim of multiple handicaps. BMAY's mother suffered a stroke of apoplexy during the pregnancy and was comatose for five days. The infant at birth was the victim of an allergy manifested by a severe skin eruption and was strapped in bed for the first year to prevent scratching. According to the record, the infant was also heavily drugged during this time with permanently damaging effects on the central nervous system postulated. Furthermore, the child has been handicapped by poor vision and very poor health in general.

Subject BXBY, on the other hand, demonstrated highly significant progress on problem 4 followed immediately by highly significant interference on problem 5. This subject typified the performance of all subjects in general pattern but at the most extreme magnitude of all. BXBY was recorded as both mentally retarded and emotionally disturbed. BXBY was adopted in early childhood. Shortly after the adoption, the adoptive father died. Thereafter the adoptive mother alternately neglected and overprotected the child.

Subject CECY showed a different kind of idiosyncracy. This subject showed highly significant progress on problem 1 and thereafter very gradually worsened in performance. CECY was recorded as mentally retarded, as speech handicapped, and as generally unmotivated by a test such as the Stanford-Binet.

Table 7.5 shows the interaction residuals for the only group of subjects where the individual idiosyncracies in intra-problem "ik" variability in performance reached a significant level. This was the low achievement group at Southern Colony.

The most highly significant idiosyncracies appeared in connection with components 1 and 2 of the problems in general. Subject APBY, for example, experienced very highly significant interference on component 2 and thereafter tended to improve slowly. APBY was recorded as a high-grade mental defective of unknown etiology, had been admitted to the institution at the age of 14 years, and had been there for nearly 30 years. The record especially noted that this subject "absorbed new learning patterns very slowly."

Subject AVCY experienced highly significant interference on the first component of the problems in general. In sharp contrast with this kind of idiosyncracy, subject BBCY experienced highly significant progress on the same component.

AVCY was recorded as a middle-grade mental defective with etiology listed as Mongolism. This subject had been admitted to the institution at the age of 7 years and had been there more than 11 years. No complicating injuries or illnesses were recorded.

BBCY was recorded as a high-grade mental defective with etiology listed as genetic ("familial") retardation. There were several complicating factors listed, such as Bell's palsy, scoliosis, and a schizoid personality disorder. This subject was admitted to the institution at the age of 19 years and had been there more than 8 years.

In general the pattern of idiosyncracies typified by AVCY may well be characteristic of very severe organic brain pathology. On the other hand, the pattern typified by BBCY may well be characteristic of primary emotional or personality disorders of chronic nature and only secondarily related to mental deficiency as a possibly negligible contributory factor. It must be recognized that such a diagnostic differentiation has long been sought, and any lead that shows promise should be explored.

III. EXPERIMENT II

Introduction

The second experiment was designed to investigate both the function of peripheral cues and the mechanism of spatial-pattern vision in discrimination in mental retardation. Basically related research approaching these problems by other techniques and for the most part using animals other than man for subjects has been reported by Postman and Senders (89), Brown and Carr (18), Thompson (114), Harlow (42), Hayes, Thompson, and Hayes (48), and Lashley (72).

While the present experiment was in progress, independent but highly relevant investigations of perception of the upright in a tilting room experiment at the Downstate Medical Center of the State University of New York were reported by Witkin (125). Very recently an effective technique for investigating perception of depth with human infants and several kinds of animals was reported by Gibson and Walk (37). Very important evidence was obtained on the interrelationships between innate structural mechanisms and learned functions in vision. The problem of determining what kinds of visual experience accelerate or retard the processes of maturation and learning remains to be studied.

In the present experiment a technique was devised and given preliminary trial for the purpose of investigating perception of apparent size and shape of a plane figure as a function of tilt. It was also designed to measure the capability of the mentally retarded to abstract relevant relationships among visual cues in a given task. No training was given, except five preliminary trials for conveying directions and orientation to the task, nor was the effect of current training at issue. The effect of previous life experience in mental retardation as such experience might have facilitated, hindered, or simply not influenced performance on this kind of visual task was the crucial issue. The populations studied was described in Tables 1.1, 1.2, 1.3, 1.4, and 1.5.

Purpose

The purpose of this second aspect of the overall investigation was to identify the essential nature of the intervening variables which were measurably predominant in the behavior of mentally retarded subjects during the testing of discriminative reactions to a variable visual stimulus in the absence of directive reinforcement. The experimental design, shown in Table 2.1, provided an exploratory test of several hypotheses. These hypotheses held that behavior in mental retardation under the prescribed experimental conditions would be characterized by:

Table 1.1 Supplementary Description of the High-Achievement Group at Southern Colony Training School.

Subjects	CA*	AA*	PIR*	ΣX_1
ABAX	225	83	142	18128
ACAX	247	220	27	18118
ADAX	153	127	26	16128
AEAX	299	183	116	16994
AFAX	209	181	28	18235
AHAX	149	108	41	18452
AIAX	394	268	126	19274
ALBX	180	37	143	18145
AMBX	355	288	67	18172
AQBX	237	186	51	18255
ARBX	182	151	31	18228
AYCX	217	170	47	18791
AZCX	247	129	118	18527
BACX	380	127	253	18710
BCCX	238	95	143	18261
Range	245	251	227	3146
Mean	247.5	156.9	90.6	18161.2
Standard Deviation	74.8	65.5	62.9	715.7
Standard Error $\bar{X}$	19.3	16.9	16.2	184.8

* Chronological Age, Admission Age, and Period of Institutional Residence in months.

Table 1.2 Supplementary Description of the Low-Achievement Group at Southern Colony Training School.

Subjects	CA	AA	PIR	ΣX_1
AAAY	204	144	60	18588
AGAY	200	40	160	18511
AJAY	229	115	114	18460
AKBY	220	185	35	17939
ANBY	201	194	7	17891
AOBY	208	189	19	17816
APBY	517	175	342	17783
ASBY	202	147	55	18486
ATBY	308	140	168	17903
AUCY	213	144	69	18048
AVCY	223	94	129	17719
AWCY	487	386	101	17231
AXCY	220	171	49	15546
BBCY	333	238	95	17743
BDCY	216	137	79	17251
Range	317	346	335	3042
Mean	265.4	166.6	98.8	17794.3
Standard Deviation	100.2	73.9	79.5	724.1
Standard Error $\bar{X}$	25.9	19.1	20.5	187.0

Table 1.3 Supplementary Description of the High-Achievement Group at Madison Public Schools.

Subjects	CA*	ASE*	AASE*	ΣX_1
BEAX	142	73	121	18639
BGAX	145	64	112	17060
BHAX	114	83	107	18973
BJAX	137	68	128	16675
BKAX	98	68	91	18631
BLAX	107	64	100	19651
BPHX	109	90	102	17488
BQHX	139	58	118	18170
BSHX	92	59	83	18540
BTHX	91	58	82	17578
BVHX	99	66	90	18282
BWHX	93	74	86	18826
CACX	105	74	86	17587
CCCX	102	71	95	18292
CFCX	98	78	90	18380
Range	54	32	46	2976
Mean	111.4	69.9	99.4	18184.8
Standard Deviation	18.8	8.9	14.3	754.0
Standard Error X	4.8	2.3	3.7	195.0

* Chronological Age, Age at School Entrance, and Age at Admission to Special Education in months.

Table 1.4 Supplementary Description of the Low-Achievement Group at Madison Public Schools.

Subjects	CA	ASE	AASE	ΣX_1
BFAY	153	60	84	17853
BIAY	138	69	93	17812
BMAY	102	82	94	17426
BNAY	134	65	89	18174
BOBY	91	58	82	19077
BRBY	96	64	88	17584
BUBY	98	66	90	18137
BXBY	108	64	93	17476
BYCY	109	90	102	18240
BZCY	91	60	84	18540
CBCY	101	69	81	18690
CDCY	95	63	87	18066
CECY	96	64	87	17545
CGCY	97	64	88	18540
CHCY	103	69	81	18690
Range	62	32	21	1651
Mean	107.5	67.1	88.2	18123.3
Standard Deviation	18.2	8.2	5.5	492.4
Standard Error $\bar{X}$	4.7	2.1	1.4	127.1

Table 1.5 Summary of the Supplementary Descriptions of the Southern Colony Training School Population Sample and the Madison Public Schools Population Sample.

Statistic	CA	AA	PIR	ΣX_1
. . . . Southern Colony Population Sample				
Range	338	349	335	3728
Mean	256.4	161.7	94.7	17977.8
Standard Deviation	88.9	70.0	71.8	741.7
Standard Error $\bar{X}$	16.2	12.8	13.1	135.4
Statistic	**CA**	**ASE**	**AASE**	**ΣX_1**
. . . . Madison Population Sample				
Range	62	32	47	2976
Mean	109.4	68.5	93.8	18154.1
Standard Deviation	18.4	8.6	12.2	637.1
Standard Error $\bar{X}$	3.4	1.6	2.2	116.3

Hypothesis 1. A significant inter-group variability in discriminative reactions as a function of the general developmental status of the different groups of subjects.

Hypothesis 2. A significant susceptibility to a response set as a function of stimulus generalization.

Hypothesis 3. A significant categorization of the clusters of discrete stimulus positions as a function of spatial-pattern discrimination.

Hypothesis 4. A significant gross differentiation of the changing magnitude of stimulus area as a function of intensity-brightness discrimination.

Hypothesis 5. A significant predominance of intensity-brightness discrimination over spatial-pattern discrimination as a function of the severity of each group's developmental impairment.

Hypothesis 6. Significant individual idiosyncracies in discriminative reactions that may contribute to differential diagnosis in new dimensions.

Method

Apparatus:

The apparatus consisted of a tilting table, a control window, and electric lights mounted inside a large rectangular plywood box measuring 39" x 18" x 18". (See Figures 1 and 3.) On the outside of the box were installed the control bar (Figure 2), the measuring arc and scale (Figure 1), an eyepiece without lenses, window controls and electric switch. The tilting table was a 12" x 12" piece of heavy plate glass mounted on a machined-offset steel axle in such manner that the horizontal axis of rotation would pass precisely across the center of the top-front surface of the plate-glass.

A single stimulus in the shape of an ellipse painted a solid black on a white paper background was prepared. The paper was attached smoothly by means of rubber cement to a thin glass plate that was 10" x 10" in size.

The black ellipse measured 4 1/2 inches on its vertical axis and 3 5/8 inches on its horizontal axis. It was presented on the tilting table at a distance of 20 inches from the subject's eye.

The visual field inside the box was controlled by a partition with an adjustable window located midway between the eyepiece and the stimulus. The window was adjustable in both horizontal and vertical dimensions by guillotine-type doors controlled by threaded steel shafts.

The visual field was adjusted during this experiment to permit a view of the entire ellipse plus not more nor less than one inch of the white background at the ends of the horizontal and vertical axes of the ellipse while positioned at maximum angle of tilt. The amount of white background

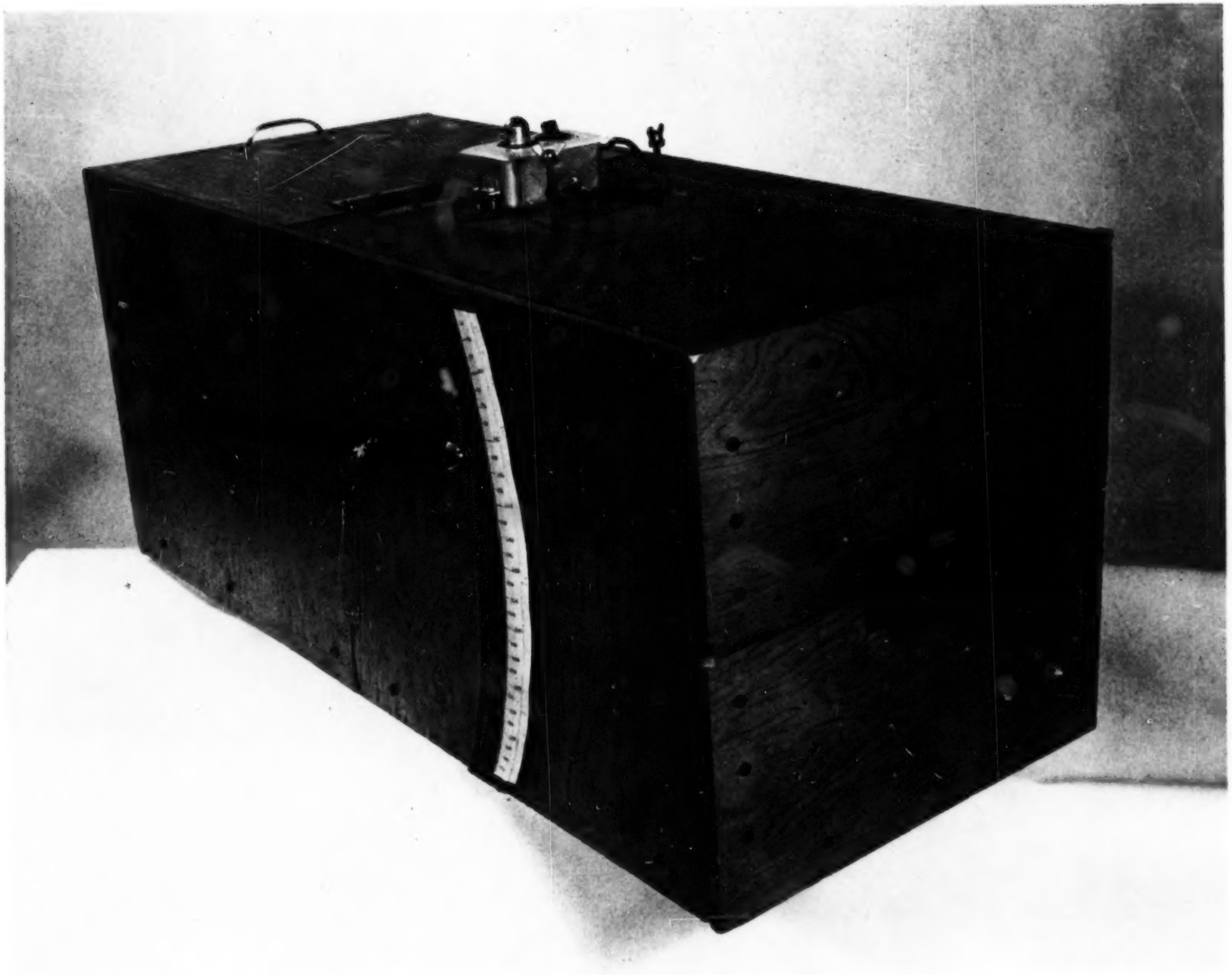

Figure 1. EXTERIOR OF TILT BOARD APPARATUS

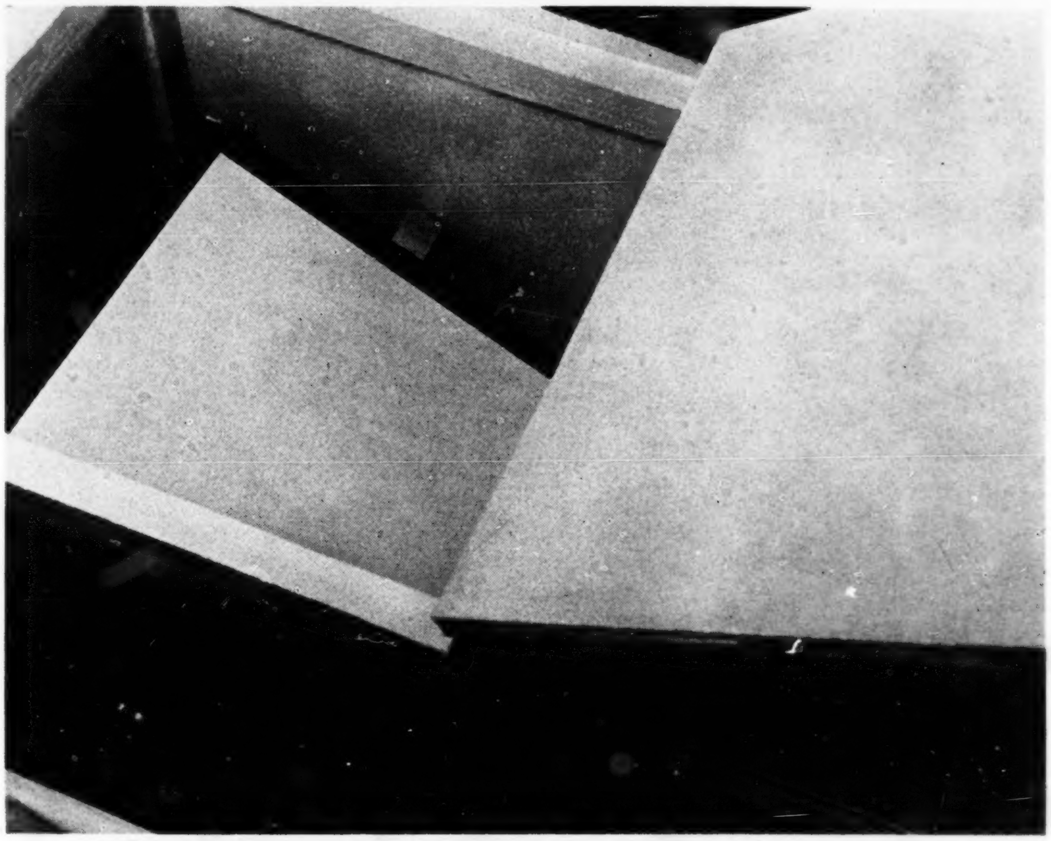

Figure 2. VIEW OF TILTING TABLE

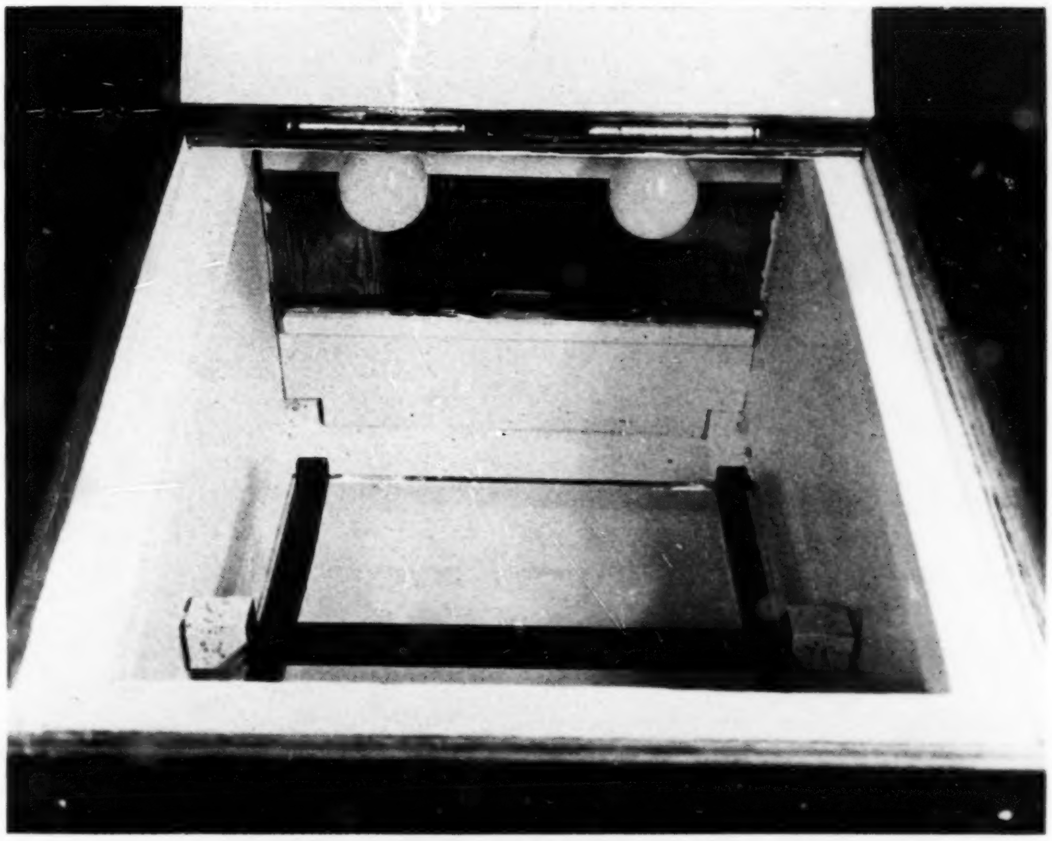

Figure 3. VIEW OF CONTROL WINDOW AND LIGHTING ARRANGEMENT

visible at each end of the horizontal axis of the ellipse remained constant during changes in tilt. On the other hand, the amount of white background at each end of the vertical axis of the ellipse increased markedly as the angle of tilt decreased to the approximately 10 degrees minimum angle of tilt used in the test.

The tilting table was lighted by two 15-watt electric lamps placed and shielded in such manner as to prevent glare in the direction of the eyepiece. The tilting table compartment of the box was painted with a light pastel shade of rubber-based paint to provide good diffusion of light.

The angle of tilt was adjustable from zero tilt, i.e., a level position of the table, to and including 55 degrees of tilt by means of a control bar and measuring scale. See Figure 1 to note the range. The subject's line of sight from the eyepiece was exactly on a level with the top surface of the tilting table when placed in the level position. The stimulus in this position was invisible to the subject.

In order to remove the effects of parallax in binocular vision, the left eyepiece was completely obstructed on the inside wall of the box out of reach of the subjects. The subjects readily noted the obstruction and randomly used the right or the left eye at the right eyepiece only. Many checked the stimulus with each eye before making a judgment.

Visual acuity was not a significant consideration with such a large stimulus in a visual field characterized by sharp black-white contrast. All these subjects had received diagnostic screening for the program of special education for the mentally retarded in the Southern Colony Training school or in the Madison Public Schools.

The response media consisted of five photographs of the stimulus distributed uniformly over the range of tilt of the apparatus. The photographs were designed to serve as anchors for judgment as well as a set of five potential responses to each stimulus presented. The probability of making all correct responses purely by chance was $(1/5)^{18}$ for the complete testing program.

The five photographs were made at the following positions of tilt of the ellipse:

(a) anchor A, at 4 degrees of tilt from the level position;

(b) anchor B, at 16 degrees;

(c) anchor C, at 28 degrees;

(d) anchor D, at 40 degrees;

(e) and ahchor E, at 52 degrees of tilt. (See Figure 4.)

The photographs were carefully designed to obtain a sharp black image of the ellipse in the center of the picture. Each photograph was placed in a separate transparent plastic sleeve to protect it during handling by the many subjects.

Procedures:

The stimulus-ellipse was presented in two different sequences of trials. In the first sequence the stimulus was presented in a so-called descending series of positions, i.e., in a series of positions of successively greater angle of tilt. In the second sequence, the very same positions of tilt were presented in reverse order in the so-called ascending series of positions of successively smaller angle of tilt.

A single sequence was composed of nine discrete stimulus positions selected in clusters of three positions near each of three different response-anchor positions, i.e., a cluster of three discrete positions near each of the anchors B, C, and D. See Figures 4, 5, 6, and 7 for the precise interrelationships of these positions and their nearest anchors. The complete testing program thus consisted of 18 trials for each subject.

At each position of the stimulus-ellipse presented to each subject, the experimenter pointed toward the ellipse inside the box, toward the eyepiece, toward the subject's eyes, and then toward the five photographs placed in the subject's hands and asked both with a questioning gesture and orally, "Which one of these pictures does that object in there look like?" It was anticipated that more elaborate pantomiming and even demonstrating might be necessary to convey the message to those who could not understand the oral question, but this proved unnecessary.

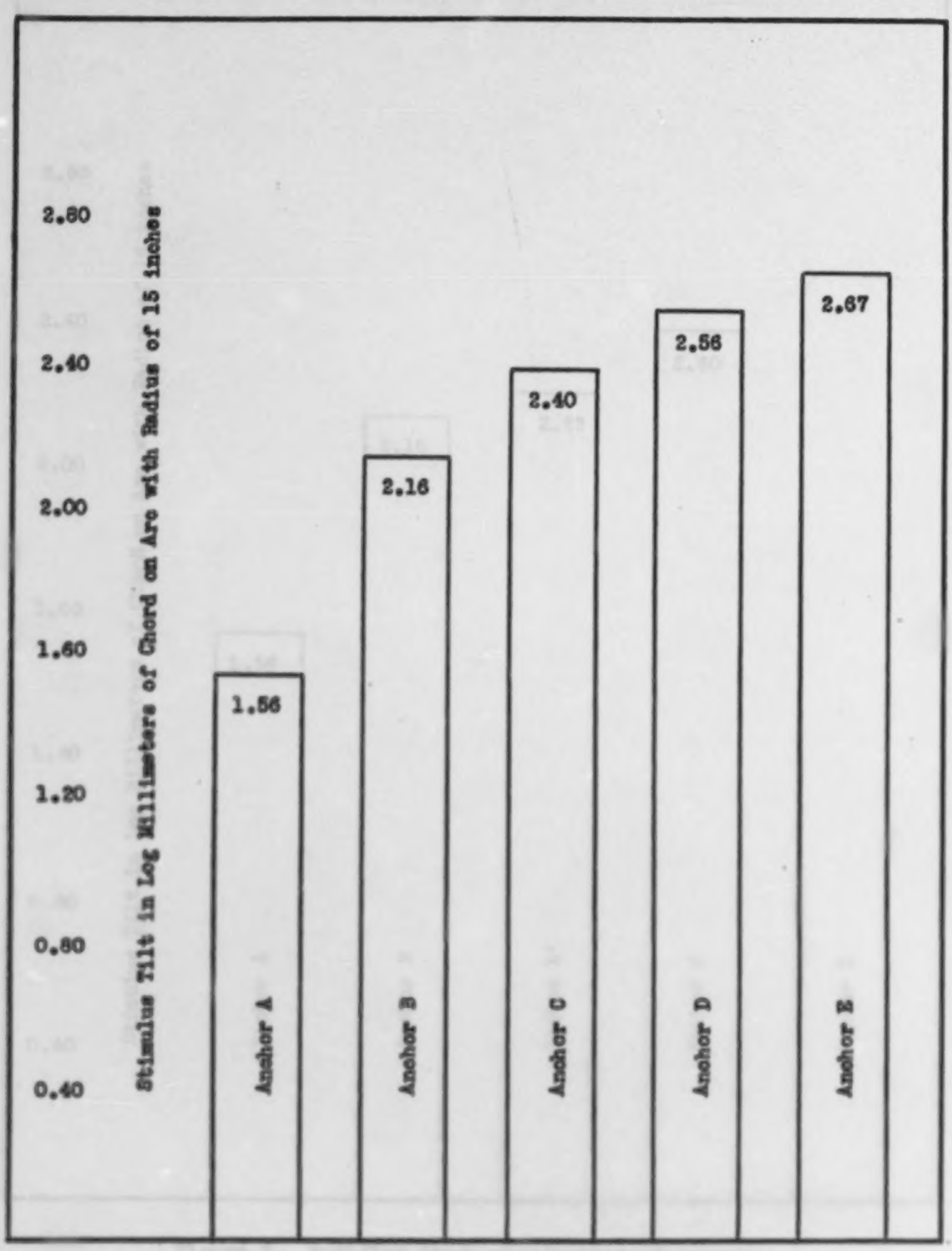

Figure 4. Range and Relative Magnitude of the Five Response-Anchors

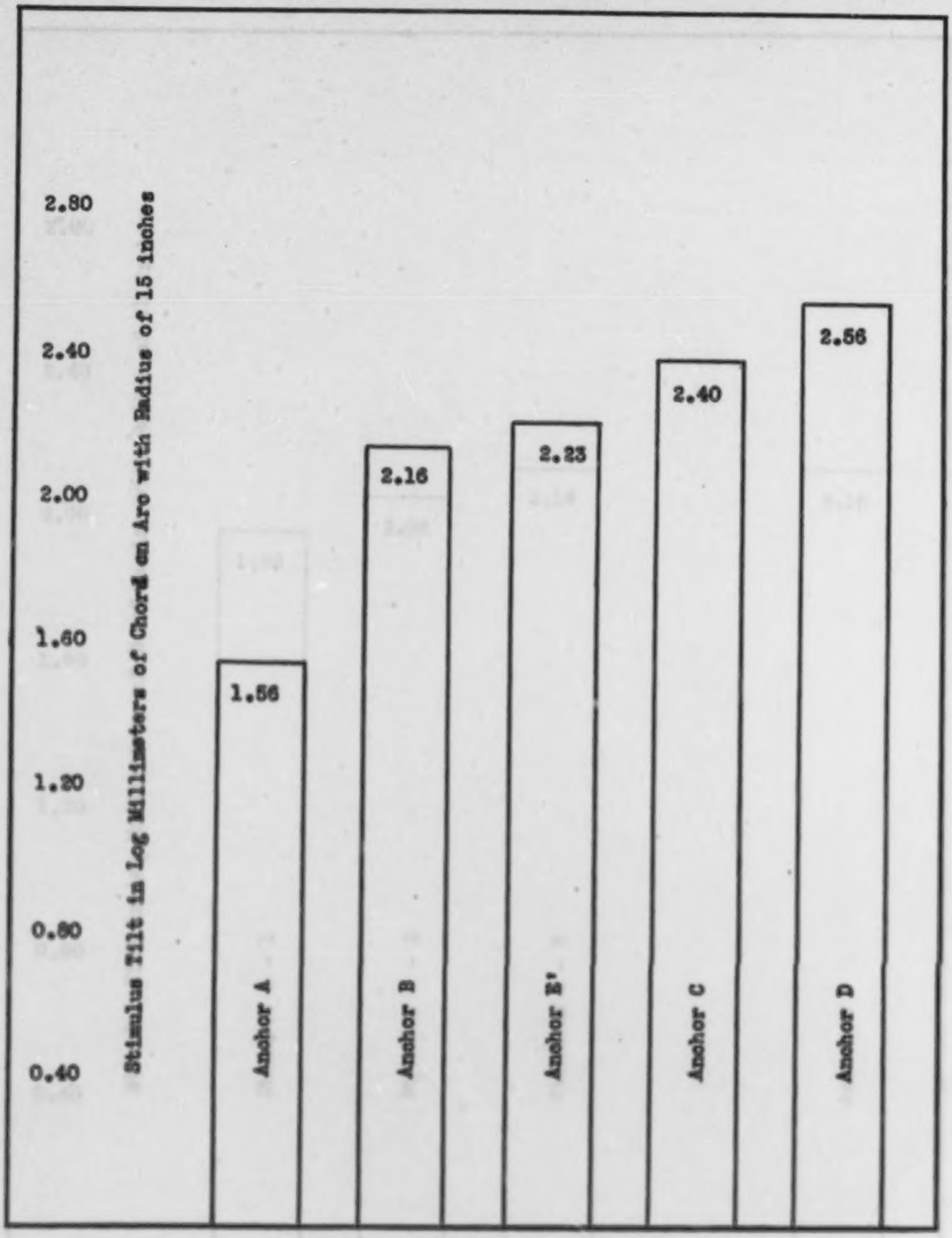

Figure 5. Modified Range and Relative Magnitude of the Five Response-Anchors Reflecting these Subjects' Idiosyncratic Treatment of Anchor E

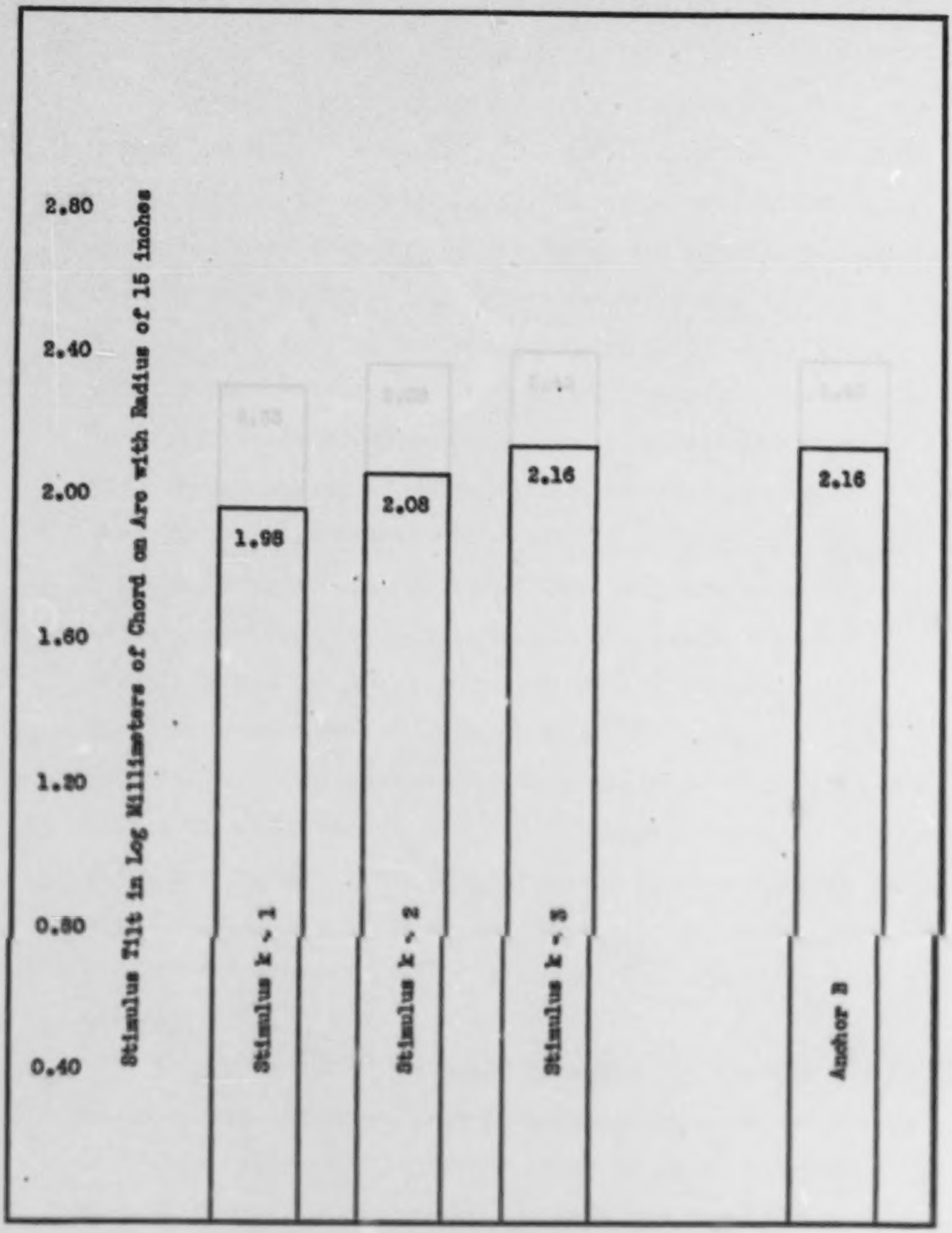

Figure 6. Range and Relative Magnitude of the Three Stimuli in Category No. 1 in Comparison with the Expected Response

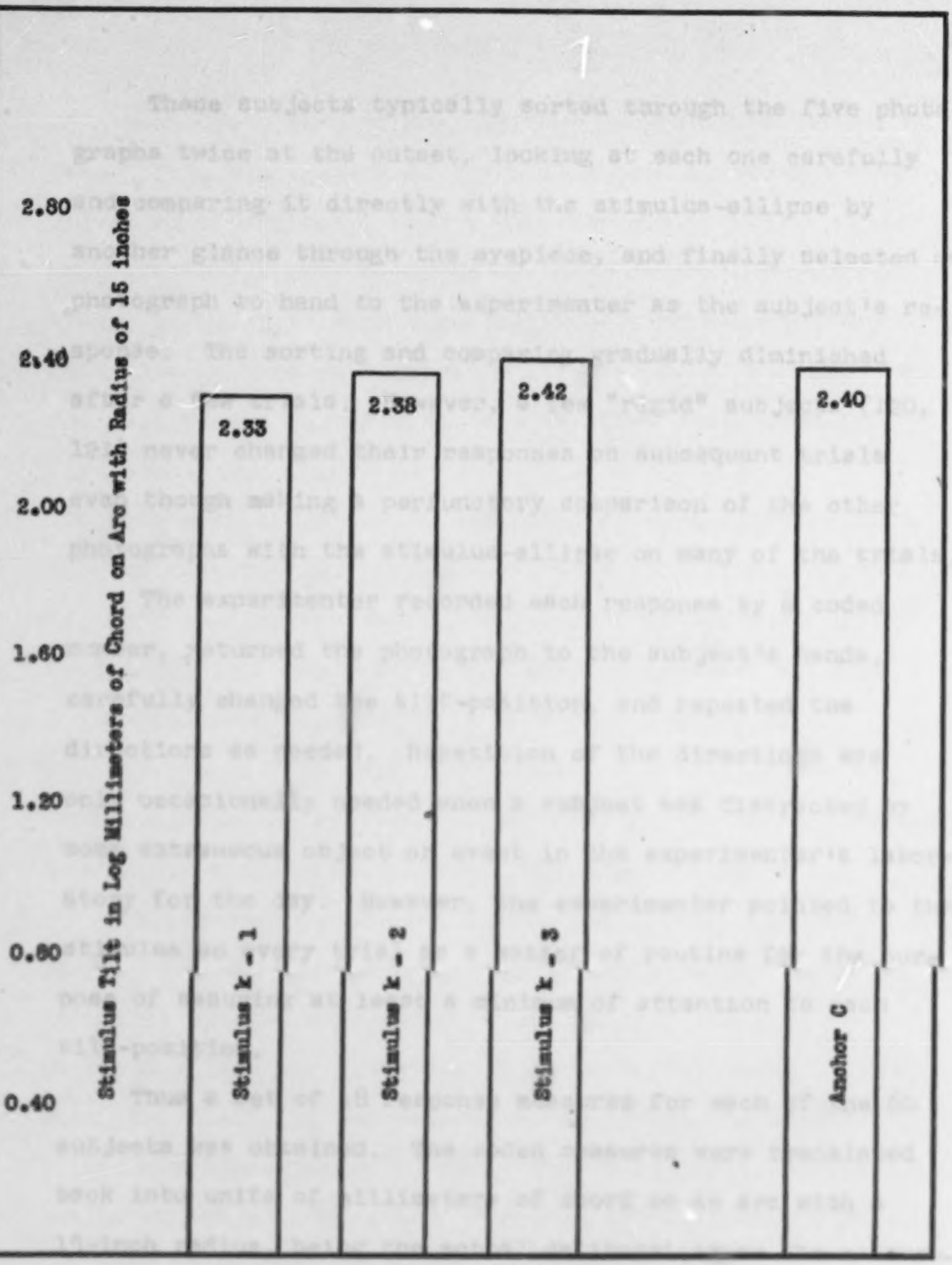

Figure 7. Range and Relative Magnitude of the Three Stimuli in Category No. 2 in Comparison with the Expected Response

These subjects typically sorted through the five photographs twice at the outset, looking at each one carefully and comparing it directly with the stimulus-ellipse by another glance through the eyepiece, and finally selected one photograph to hand to the experimenter as the subject's response. The sorting and comparing gradually diminished after a few trials. However, a few "rigid" subjects (120, 121) never changed their responses on subsequent trials even though making a perfunctory comparison of the other photographs with the stimulus-ellipse on many of the trials.

The experimenter recorded each response by a coded number, returned the photograph to the subject's hands, carefully changed the tilt-position, and repeated the directions as needed. Repetition of the directions was only occasionally needed when a subject was distracted by some extraneous object or event in the experimenter's laboratory for the day. However, the experimenter pointed to the stimulus on every trial as a matter of routine for the purpose of assuring at least a minimum of attention to each tilt-position.

Thus a set of 18 response measures for each of the 60 subjects was obtained. The coded measures were translated back into units of millimeters of chord on an arc with a 15-inch radius, being the actual calibrations on the measuring scale of the apparatus. See Figure 1 for the relationship of the control bar with its sharp point to this measuring scale.

Next the values of the response-anchors were transformed from millimeters to log millimeters by means of Briggsian logarithms. Then a separate distribution of the logarithmic response measures was made for each response-anchor category in each sequence, requiring six distributions. Each distribution was comprised of three response measures for each of the 60 subjects, a total of 180 measures per distribution.

The mean and standard deviation of each distribution were calculated, and the measures were finally transformed from log millimeters to standard scores (Z Scores). Then for purposes of analysis of variance, a constant value of 10 was combined algebraically with each Z score to eliminate negative signs. In this final form the data (ZAV scores) were subjected to analysis of variance in the complex repeated-measurements factorial design (108) shown in Table 2.1.

Having observed during the course of the experiment that many of the subjects were apparently using response-anchor E in a very unexpected fashion, i.e., turning the picture sideways and apparently assigning it a subjective value to meet their own needs, it was decided to calculate the mean stimulus-association value for anchor E as the entire population of subjects used it. For this calculation the data in units of log millimeters were utilized.

When the new value for response-anchor E' was obtained, it was substituted in the body of data wherever the former value appeared. See Figure 8 for the new inter-relationships

Table 2.1 The Repeated-Measurements Design for Experiment II with the Factorial Notation $(\underline{X}_{ghijck})$.

Population Samples (g)	Achievement Groups (h)	Individuals (i)	j Descending	j Ascending
			Categories 1 . C	Categories 1 . C
			Stimuli 1 . K ...	Stimuli ... 1 . K
Southern Colony Training School	High	1 . 15		
	Low	1 . 15		
Madison Public Schools	High	1 . 15		
	Low	1 . 15		

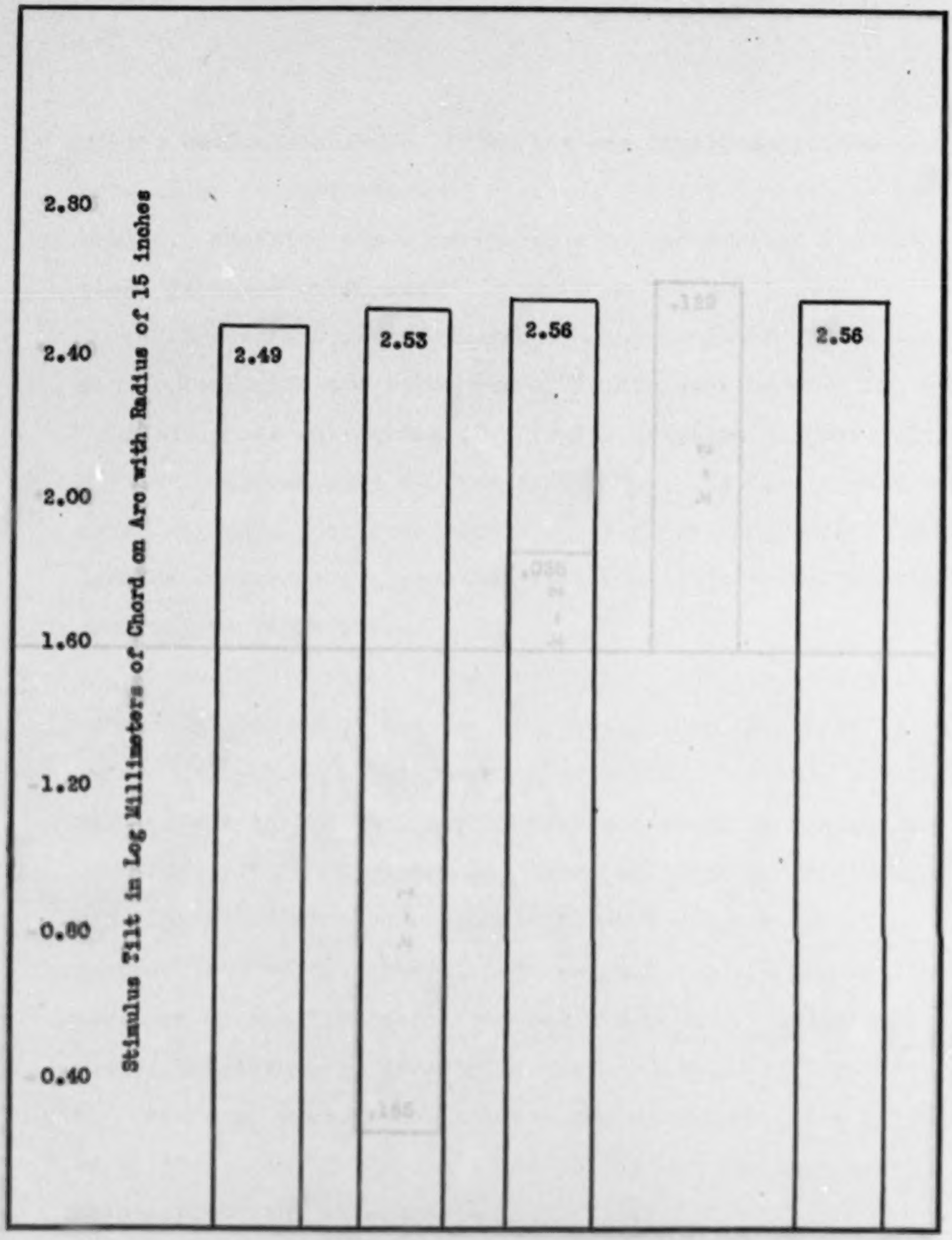

Figure 8. Range and Relative Magnitude
of the Three Stimuli in Category No. 3
in Comparison with the Expected Response

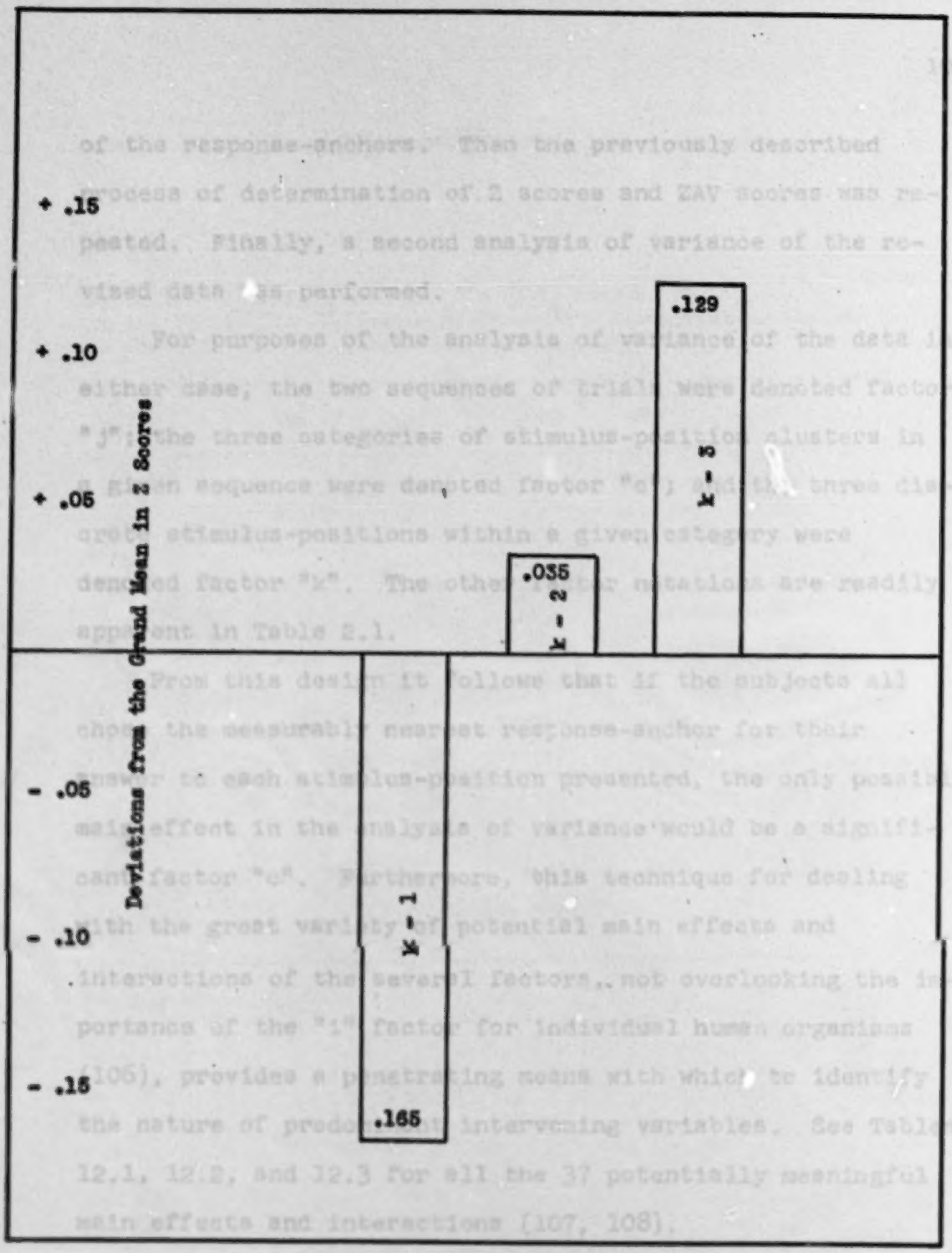

Figure 9. Pattern of Differentiation of the Three Stimuli within each Category

of the response-anchors. Then the previously described process of determination of Z scores and ZAV scores was repeated. Finally, a second analysis of variance of the revised data was performed.

For purposes of the analysis of variance of the data in either case, the two sequences of trials were denoted factor "j"; the three categories of stimulus-position clusters in a given sequence were denoted factor "c"; and the three discrete stimulus-positions within a given category were denoted factor "k". The other factor notations are readily apparent in Table 2.1.

From this design it follows that if the subjects all chose the measurably nearest response-anchor for their answer to each stimulus-position presented, the only possible main effect in the analysis of variance would be a significant factor "c". Furthermore, this technique for dealing with the great variety of potential main effects and interactions of the several factors, not overlooking the importance of the "i" factor for individual human organisms (106), provides a penetrating means with which to identify the nature of predominant intervening variables. See Tables 12.1, 12.2, and 12.3 for all the 37 potentially meaningful main effects and interactions (107, 108).

Table 2.2 Description of the Six Distributions of Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Factor	Anchor	diff.	Mean *	SD	SE
J_1C_1	2.158	.117	2.275	.178	.013
C_2	2.401	.001	2.400	.146	.011
C_3	2.556	.126	2.430	.118	.009
J_2C_3	2.556	.127	2.429	.142	.011
C_2	2.401	.022	2.379	.179	.013
C_1	2.158	.072	2.230	.170	.013

* Log MM

Results

The means and standard deviations of the six distributions of the revised data are presented in Table 2.2 to show the magnitude of response habit for the entire sample of subjects. However, the use of standard scores derived from these six separate distributions made it possible to go beyond this effect and identify by means of analysis of variance any characteristic differential kinds of discriminative reactions after neutralizing the effect of stimulus generalization for the entire group.

The rather equivocal outcome of the first series of analyses of variance of the original ZAV data are presented in a series of tables summarizing the calculations. The first four tables, viz., Tables 3.1, 4.1, 5.1, and 6.1, separately present the results of the independent analyses of variance for each group of subjects in the 2x2 design of the non-correlated group variables. The independent analyses made it possible to assess the relative contribution of any given group to a significant main effect or interaction of factors in the total factorial design. The next three tables, viz., Tables 7.1, 7.2, and 7.3, present the exhaustive analysis of variance of these data for the entire factorial design. All logically possible main effects and interactions of factors in this type of design were tested for significance.

Table 3.1 Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the High-Achievement Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	293448	14	20961		
k	860	2	430	0.05	
e	20146	2	10073	2.04	
j	17860	1	17860	1.87	
ik	237804	28	8493	0.98	
ie	138032	28	4930	0.57	
ij	133788	14	9556	1.10	
ke	33790	4	8448	2.48	
kj	4441	2	2221	0.75	
ej	33351	2	16676	1.99	
ike	191013	56	3411	0.39	
ikj	84441	28	3016	0.35	
iej	235214	28	8401	0.97	
kej	12643	4	3161	0.36	
ikej	487004	56	8697		
Total	1923835	269			

* Probability is indicated only where F is considered significant.

Table 4.1 Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the Low-Achievement Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	738355	14	52740		
k	16079	2	8040	1.49	
c	78770	2	39385	2.72	
j	12026	1	12026	1.57	
ik	151068	28	5395	1.39	
ic	405021	28	14465	3.72	.01
ij	123222	14	8802	2.26	.05
kc	14149	4	3537	0.69	
kj	40826	2	20413	3.45	.05
cj	14994	2	7497	0.81	
ikc	285733	56	5102	1.31	
ikj	166804	28	5957	1.53	
icj	258698	28	9239	2.38	.01
kcj	17981	4	4495	1.16	
ikcj	217807	56	3889		
Total	2541533	269			

* Probability is indicated only where F is considered significant.

Table 5.1 Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the High-Achievement Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	498442	14	35603		
k	14332	2	7166	0.99	
c	42358	2	21179	1.78	
j	81258	1	81258	6.10	.05
ik	202146	28	7220	0.84	
ic	333492	28	11910	1.39	
ij	186415	14	13315	1.55	
kc	13269	4	3317	0.36	
kj	3175	2	1588	0.17	
cj	21834	2	10917	1.84	
ikc	512365	56	9149	1.06	
ikj	268099	28	9575	1.11	
icj	198563	28	7092	0.83	
kcj	5369	4	1342	0.16	
ikcj	481590	56	8600		
Total	2862727	269			

* Probability is indicated only where F is considered significant.

Table 6.1 Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the Low-Achievement Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	209405	14	14957		
k	31363	2	15682	3.39	.05
c	36879	2	18440	1.58	
j	398	1	398	0.03	
ik	129383	28	4621	0.73	
ic	326929	28	11676	1.85	.05
ij	168951	14	12068	1.91	.05
kc	31126	4	7782	1.39	
kj	3890	2	1945	0.79	
cj	44198	2	22099	3.25	
ikc	313428	56	5597	0.89	
ikj	68607	28	2450	0.39	
icj	190169	28	6792	1.08	
kcj	44022	4	11006	1.74	
ikcj	353354	56	6310		
Total	1952100	269			

* Probability is indicated only where F is considered significant.

Table 7.1 Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
k	45094	2	22547	3.51	.05
e	109087	2	54544	5.08	.05
j	64620	1	64620	5.91	.05
h	7003	1	7003	0.02	
g	2558	1	2558	0.01	
ke	8082	4	2021	0.35	
kj	6318	2	3159	0.60	
kh	11580	2	5790	0.90	
kg	3960	2	1980	0.31	
ej	106596	2	53298	5.76	.01
eh	3674	2	1837	0.17	
eg	59242	2	29621	2.76	
jh	27059	1	27059	2.48	
jg	118	1	118	0.01	
hg	12937	1	12937	0.42	

* Probability is indicated only where F is considered significant.

Table 7.2 Continued Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
kmj	24590	4	6148	0.59	
kmh	41145	4	10286	1.77	
kmg	31798	4	7950	1.38	
kjh	4850	2	2425	0.46	
kjg	32710	2	16355	3.16	
khg	2000	2	1000	0.16	
ejh	631	2	316	0.04	
ejg	3492	2	1746	0.22	
ehg	6151	2	3076	0.29	
jhg	19747	1	19747	1.81	
kejh	43082	4	10771	1.87	
kejg	5910	4	1478	0.22	
kehg	11309	4	2827	0.49	
kjhg	8453	2	4227	0.81	
ejhg	3656	2	1828	0.25	
kejhg	6434	4	1609	0.25	
Total	713886	71			

* Probability is indicated only where F is considered significant.

Table 7.3 Continued Summary of the Analysis of Variance of the Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P *
i	1739648	56	31065		
ik	720401	112	6432	0.94	
ie	1203474	112	10745	1.56	.01
ij	612376	56	10935	1.59	.05
ike	1302539	224	5815	0.85	
ikj	587951	112	5250	0.76	
iej	882664	112	7881	1.15	
ikej	1539755	224	6874		
Total	8588808	1008			

* Probability is indicated only where F is considered significant.

The clear-cut, though very parsimonious, outcome of the subsequent series of analyses of variance of the revised ZAV data are presented in the next set of seven tables, viz., Tables 8.1, 9.1, 10.1, 11.1, 12.1, 12.2, and 12.3. The arrangement of tables just described for the former series of analyses is repeated here in this series.

The magnitude of the one significant main effect, "k", is shown in Figure 8. Tables 13.1, 13.2, and 14.1 present the interaction residuals of significant interactions involving individual subjects in the low groups that contributed most to the interactions. See Tables 9.1, 11.1 and 12.3 for these "ic" and "ij" interactions.

Discussion

Hypothesis 1.

A significant inter-group variability in discriminative reactions did not appear in either series of analyses. See factors "g" and "h", representing the two grouping dimensions, in Tables 12.1 and 7.1. The revised data showed a much stronger trend toward inter-group variability on the "h" achievement dimension than the original data showed, but whatever trend existed must be considered negligible.

This is evidence that the range of general developmental maturity and the range of problem-solving achievement represented in this sample population had no significant effect on variability in the kind of discrimination required by this

Table 8.1 Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the High-Achievement Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
i	426822	14	30487		
k	25798	2	12899	2.04	
c	48613	2	24307	2.53	
j	12160	1	12160	1.15	
ik	177380	28	6335	0.87	
ic	268708	28	9597	1.31	
ij	148551	14	10611	1.45	
kc	12880	4	3220	0.94	
kj	32209	2	16105	2.25	
cj	6382	2	3191	0.49	
ikc	192402	56	3436	0.47	
ikj	200040	28	7144	0.98	
icj	181990	28	6500	0.89	
kcj	35735	4	8934	1.22	
ikcj	409368	56	7310		
Total	2179039	269			

* Probability is indicated only where F is considered significant.

Table 9.1 Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the Low-Achievement Group at Southern Colony.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
i	435996	14	31143		
k	38666	2	19333	4.85	.05
e	11096	2	5548	0.32	
j	5	1	5	0.00	
ik	111675	28	3988	1.02	
ie	491865	28	17567	4.51	.01
ij	173923	14	12423	3.19	.01
ke	19944	4	4986	1.17	
kj	20627	2	10314	1.32	
ej	2905	2	1453	0.23	
ike	238037	56	4251	1.09	
ikj	177914	28	6354	1.63	
iej	176270	28	6295	1.62	
kej	37950	4	9488	2.44	
ikej	218099	56	3895		
Total	2154972	269			

* Probability is indicated only where F is considered significant.

Table 10.1 Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the High-Achievement Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
i	473819	14	33844		
k	26058	2	13029	1.49	
c	20801	2	10401	0.50	
j	39313	1	31313	1.74	
ik	245127	28	8755	0.83	
ic	578883	28	20674	1.96	.05
ij	316262	14	22590	2.14	.05
kc	25859	4	6465	0.71	
kj	4276	2	2138	0.18	
cj	28248	2	14124	2.14	
ikc	510282	56	9112	0.86	
ikj	333697	28	11918	1.13	
icj	184388	28	6585	0.62	
kcj	70729	4	17682	1.68	
ikcj	590935	56	10552		
Total	3448677	269			

* Probability is indicated only where F is considered significant.

Table 11.1 Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the Low-Achievement Group at Madison.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
i	201069	14	14362		
k	86477	2	43239	5.77	.01
c	30719	2	15360	0.76	
j	5936	1	5936	0.53	
ik	209713	28	7490	0.92	
ic	565082	28	20182	2.49	.01
ij	156569	14	11184	1.38	
kc	47049	4	11762	1.19	
kj	122	2	61	0.01	
cj	51674	2	25837	2.67	
ikc	555611	56	9922	1.22	
ikj	225916	28	8068	0.99	
icj	271224	28	9687	1.19	
kcj	27013	4	6753	0.83	
ikcj	454612	56	8118		
Total	2888786	269			

* Probability is indicated only where F is considered significant.

Table 12.1 Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
k	162243	2	81122	12.21	.01
c	27091	2	13546	0.80	
j	13140	1	13140	0.93	
h	38223	1	38223	1.39	
g	25902	1	25902	0.94	
kc	40776	4	10194	1.53	
kj	17760	2	8880	1.06	
kh	7606	2	3803	0.57	
kg	4805	2	2403	0.36	
cj	26426	2	13213	1.82	
ch	6820	2	3410	0.20	
cg	64640	2	32320	1.90	
jh	37606	1	37606	2.65	
jg	43	1	43	0.00	
hg	19431	1	19431	0.71	

* Probability is indicated only where F is considered significant.

Table 12.2 Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
koj	55624	4	13906	1.86	
koh	56089	4	14022	2.10	
kog	3671	4	918	0.14	
kjh	413	2	207	0.02	
kjg	31007	2	15504	1.85	
khg	2346	2	1173	0.18	
ojh	832	2	416	0.06	
ojg	39431	2	19716	2.71	
ohg	12678	2	6339	0.37	
jhg	6626	1	6626	0.47	
kojh	32594	4	8149	1.09	
kojg	42250	4	10563	1.41	
kohg	5195	4	1299	0.19	
kjhg	8052	2	4026	0.48	
ojhg	22519	2	11260	1.55	
kojhg	40962	4	10241	1.37	
Total	852800	71			

* Probability is indicated only where F is considered significant.

Table 12.3 Continued Summary of the Analysis of Variance of the Revised Data on the Visual Discrimination of Successive Categories of Stimuli by the Total Sample of Mentally Retarded Subjects.

Source of Variance	Sum of Squares	Degrees of Freedom	Estimate of Variance	F	P*
i	1537706	56	27459		
ik	743895	112	6642	0.89	
ic	1904538	112	17005	2.28	.01
ij	795305	56	14202	1.90	.01
ikc	1496333	224	6680	0.89	
ikj	937567	112	8371	1.12	
icj	813872	112	7267	0.97	
ikcj	1673014	224	7469		
Total	9902230	1008			

* Probability is indicated only where F is considered significant.

Table 13.1 The First-Order Interaction Residuals of the Three Anchor-Judgment Categories with the Fifteen Organisms in the Low-Achievement Group at Southern Colony.

Subjects	Anchor-Judgment Categories		
	1	2	3
AAAY	- 431	+ 408	+ 22
AGAY	+ 4	- 59	+ 55
AJAY	- 575	+ 146	+ 428
AXBY	- 283	- 654	+ 938*
ANBY	- 117	- 133	+ 249
AOBY	- 147	+ 145	+ 1
APBY	- 196	+ 309	- 112
ASBY	- 586	+ 402	+ 184
ATBY	+ 323	+ 404	- 727*
AUCY	+ 369	- 15	- 355
AVCY	+ 982*	- 199	- 783*
AWCY	- 32	- 295	+ 326
AXCY	+ 904*	- 87	- 818*
BBCY	- 244	+ 203	+ 42
BDCY	+ 29	- 574	+ 545

* The largest residuals indicate highly significant idiosyncracies. A positive sign indicates a tendency to be influenced by the larger anchors (farther to the right on the anchor scale) more than the mean total-group response for each category.

Table 13.2 The First-Order Interaction Residuals of the Three Anchor-Judgment Categories with the Fifteen Organisms in the Low-Achievement Group at Madison.

Subjects	Anchor-Judgment Categories 1	2	3
BFAY	- 1058*	+ 117	+ 941*
BIAY	+ 679	- 1071*	+ 390
BMAY	- 292	+ 39	+ 253
BNAY	+ 168	- 377	+ 207
BOBY	+ 226	- 267	+ 41
BRBY	- 327	+ 241	+ 85
BUBY	- 741	+ 292	+ 448
BXBY	+ 66	- 309	+ 242
BYCY	+ 209	+ 70	- 279
BZCY	+ 542	- 97	- 446
CBCY	- 256	+ 238	+ 18
CDCY	- 256	+ 238	+ 18
CECY	+ 15	+ 166	- 183
CGCY	+ 480	+ 809*	- 1290*
CHCY	+ 542	- 97	- 446

* The largest residuals indicate highly significant idiosyncracies. A positive sign indicates a tendency to be influenced by the larger anchors (father to the right on the anchor scale) more than the mean total-group response for each category.

Table 14.1 The First-Order Interaction Residuals of the Two Series of Trials with the Fifteen Organisms in the Low-Achievement Group at Southern Colony.

Subjects	Series of Trials 1	2
AAAY	- 35	+ 35
AGAY	+ 322*	- 323*
AJAY	+ 65	- 65
AKBY	- 167	+ 168
ANBY	+ 181	- 181
AOBY	- 70	+ 71
APBY	+ 248	- 248
ASBY	- 160	+ 161
ATBY	+ 229	- 229
AUCY	- 345*	+ 345*
AVCY	+ 584*	- 583*
AWCY	- 245	+ 246
AXCY	- 180	+ 179
BBCY	- 158	+ 159
BDCY	- 272	+ 272

*** The largest residuals indicate highly significant idiosyncracies. A positive sign indicates a tendency to be influenced by the larger anchors (farther to the right on the anchor scale) more than the total population sample is.**

experiment. For purposes of this kind of task all subjects were quite similarly and severely impaired.

Since the kind of visual task involved in this kind of experiment, viz., differentiating gradual variations in the spatial-pattern of a black ellipse, has considerable logical and visual similarity to the task of differentiating the variations in spatial-pattern of the holes in the blocks in the preceding experiment, a tentative conclusion may be offered as the basis for further experimentation. All groups of subjects in this entire investigation were so impaired that they could not and did not make any significant spatial-pattern discriminations, except the gross differentiations dependent upon primitive neural functions (103).

It is recognized that this conclusion would relegate their problem-solving behavior essentially to trial-and-error manipulation in varying stages of eliminative efficiency. This in turn would seem to imply that they may be unable to learn to make spatial-pattern discriminations, which is a very questionable implication in view of the work of Strauss and Lehtinen (111), Werner and Strauss (122), and Goldstein (39), as well as others. Nevertheless, even in the work of these investigators this kind of impairment surely remained ominously in the background. It becomes dominant where no special training methods are available to help individuals with such severe perceptual impairment.

Hypothesis 2.

A very significant susceptibility to a response set was found to be the dominant factor in the behavior of all groups. See Table 2.2 for the magnitude of convergence of judgment toward the center of the range of stimulus-positions. In general, excessive stimulus generalization replaced the expected discrimination under the conditions of this experiment. This conclusion received further support from the absence of any significant factor "c" discussed next below. Thus the dominant response habit was accompanied by absence of any significant tendency to make spatial-pattern discriminations.

Hypothesis 3.

A significant categorization of the clusters of discrete stimulus positions was conspicuous by its absence. See factor "c" in Table 12.1 and compare the results for each group in Tables 8.1, 9.1, 10.1, and 11.1. Only in the case of the high-achievement group at Southern Colony was there even a negligible hint of the function of spatial-pattern discrimination (See Table 8.1). A few individuals in that group may not be so typically impaired.

Hypothesis 4.

A significant gross differentiation of general magnitude of stimulus area was the only significant main effect remaining in the revised data after taking account of the unexpected usage of anchor E. See factor "k" in Table 12.1 and compare the contributions of the separate groups in Tables 8.1, 9.1, 10.1, and 11.1 to factor "k".

It was very notable in Table 8.1 that the group which made the negligible contribution to factor "k" was the same group that showed the strongest hint of spatial-pattern discrimination. It would seem that this particular high group might be composed of two kinds of individuals, viz., (a) those who were making some effective spatial-pattern discriminations and (b) those who were limited to gross intensity-brightness discriminations typical of the main bulk of subjects.

Another interpretation of this negligible contribution to factor "k" by the high group raises an interesting question for further research. Were two basic kinds of discrimination processes functioning in competition for many or most of the individuals in this high group, resulting in negligible effectiveness? For such individuals, training on a similar task with some directive reinforcement provided at appropriate stages might overcome the confusing competition and result in a spatial-pattern discrimination learning set (15, 29, 118, 130). If, on the other hand, the former interpretation is correct, then the cleavage in the group would be emphasized.

Hypothesis 5.

A significant predominance of intensity-brightness discrimination over spatial-pattern discrimination was found as an increasing function of decreasing group status on the developmental maturity and achievement dimensions. See the increasing values of factor "k" in Tables 8.1, 9.1, 10.1, and 11.1. At the upper end of the grouping dimensions (Table 8.1), on the other hand, the value of factor "k" was negligible in importance.

Analysis of these basic functions of so-called "perception" offers a promising means of understanding the nature of mental retardation as it affects learning. It has very recently been suggested that the so-called "process of perception" ~~needs to be clarified (76).~~ Compare the approach taken at Downstate Medical Center and that more recently taken at Cornell (37, 125).

Hypothesis 6.

Significant individual idiosyncracies in discriminative reactions were found to be characteristic of the entire population of subjects studied. See the "ic" and "ij" interactions in Table 12.3. See Tables 9.1 and 11.1 for the largest group contributions to these significant interactions.

The low achievement groups were clearly the source of greater idiosyncracy in performance. An analysis of these idiosyncracies is quite revealing. See Tables 13.1, 13.2, and 14.1. The nature of these idiosyncracies varies from extreme response habit on the part of certain individuals to unique patterns of discrimination on the part of other individuals.

Starting with Table 13.1 on the group of low-achievers at Southern Colony, the most significant idiosyncracies were associated with subject AXCY. Here was the most extreme response habit, i.e., convergence of judgment toward the center of the range of categories, in the group. AXCY was recorded as a victim of genetic ("familial") deficiency and was considered a middle-grade mental defective. A maternal uncle was also recorded a mental defective and the mother an epileptic. Impaired motor coordination and marked perseverative tendencies were recorded.

An example of very highly significant discriminative idiosyncracies was found in subject AKBY. This subject showed the greatest tendency in the group to differentiate the three anchor-judgment categories in the expected manner. AKBY was recorded as a congenital spastic and a victim of infantile paralysis. This subject was considered a high-grade mental defective on admission to the institution at age 15 years.

Turning to the idiosyncracies of the low-achievement group at Madison, similar extreme tendencies toward a response habit, on the one hand, and unique discriminations, on the other, were also revealed. See Table 13.2.

Subject CGCY demonstrated the most extreme response habit in this group of subjects. CGCY was recorded as extremely distractible, an eight-year-old with a mental age of about 4 1/2 years, and always very obese. The developmental history showed that CGCY was born a "blue baby," was fed intravenously for the first five weeks, and showed symptoms of thyroid deficiency. This subject also had very poor vision in one eye and manifested a protruding tongue most of the time.

An example of unique discrimination, on the other hand, was subject BFAY, who showed a highly significant trend toward differentiation of the three anchor-judgment categories in the expected manner. BFAY was recorded as a 12-year-old with a mental age of about 9 years. This subject was also recorded as having infantile speech patterns and very infantile emotional reactions. One psychometrist had noted on the record that this subject persisted in giving differences where similarities were needed on a WISC subtest.

Here again, just as in the idiosyncratic behavior noted in the previous experiment, opposite idiosyncratic tendencies depending upon the severity of organic impairment (CGCY) or the presence of severe emotional disturbance (BFAY) appeared. Differential diagnosis would require primary attention to the alleviation of emotional maladjustment of BFAY and, on the other hand, primary attention to rudimentary sensory training techniques for CGCY, as developed for "brain-injured" children by Strauss and Lehtinen (111).

IV. SUGGESTED RESEARCH

Several questions needing further study were raised in the preceeding chapters. What innate structural conditions and previous learning experiences for the mentally retarded facilitate speed of problem solving despite negative transfer? What facilitating effects on learning would accrue if emphasis were placed on intensity-brightness and peripheral characteristics of training materials? How much improvement can mentally retarded subjects make in spacial-pattern discriminations with special training methods? Are two basic kinds of discrimination processes functioning in competition for many of these individuals and can training overcome this rivalry? What is the nature of the process of perception in the mentally retarded? What specific maturational factors are predominant in producing the superior performance manifested by the group with greater developmental maturity, but lower mental development? To what extent can training utilizing peripheral cues be used to produce more effective learning in general? How may the preoccupation with peripheral cues be minimized or eliminated?

There should also be further study of the leads offered in this research for possible differentiation of retarded behavior rooted in severe organic brain pathology from that associated with emotional or personality disorders of chronic nature.

Study of the neurophysiological correlates of special forms of behavior in the mentally retarded looks particularly intriguing and promising especially when coupled with neurochemical and neuro-electrical approaches.

In addition to the above it would seem appropriate to suggest in highly specific form some further research involving the equipment and techniques used in this research project.

Design #1

Subjects

Select 270 mentally retarded subjects, plus a reserve group of 27 for attrition, on the basis of the following criteria:

1. Participation in a recognized program of special education for the mentally retarded.
2. Chronological age limitations of 90 through 114 months.
3. Participation in a delayed reaction test designed for increasing frustration to assure identification of an adequate number of subjects with significant emotional disturbances.
4. Successful solution of the problems shown in Figures 2 and 3 as the pre-training sequence for the advanced test.

Administer the advanced block-assembly test and select three groups (each N = 90) of subjects as follows:

G1. Those who readily succeed with the advanced test.

G2. Those who succeed only after training on the three separate components of the advanced test.

G3. Those who fail even after training on the separate components.

Administer the tilt-board discrimination test and subdivide each group into three parts as follows:

H1. Those who show the greatest stimulus-generalization on the individual by category ("i x c") interaction.

H2. Those who show only a negligible deviation from the typical group performance~~.~~ "~~i x c~~"

H3. Those who show a significant discrimination learning set. "i x c"

Having obtained the basic groups of subjects, administer a set of 4 problems especially designed to identify the nature of cues being utilized in performance as follows:

Factor "R"	Factor "J" Presentation Array No.*			
	Factor "C"			
	C1	C2	C3	C4
R1	4* k 1-5	1 k 1-5	5 k 1-5	6 k 1-5
R2	1 k 1-5	5 k 1-5	6 k 1-5	4 k 1-5
R3	5 k 1-5	6 k 1-5	4 k 1-5	1 k 1-5
R4	6 k 1-5	4 k 1-5	1 k 1-5	5 k 1-5

This design permits testing of the following hypotheses:

Hypothesis 1. A significant main effect of factor "G" as a function of degree of impairment of each group in performance.

Hypothesis 2. A significant main effect of factor "H" as a function of nature of impairment in discrimination.

Hypothesis 3. A significant main effect of factor "J" as a function of irrelevant cues in transfer.

Hypothesis 4. A significant main effect of factor "K" as a function of differential attention to relevant-irrelevant cues.

Hypothesis 5. A significant main effect of factor "R" as a function of discrimination learning set in sequential partially-counterbalanced stages.

Hypothesis 6. A significant main effect of factor "C" as a function of discrimination learning set in cross-sequential, partially but differentially counterbalanced stages.

Hypothesis 7. A significant interaction of factors "R" and "C" as a function of acquisition of discrimination learning set.

Hypothesis 8. A significant interaction of factors "G" and "R" and "C" as a function of the differential effects on acquisition of discrimination learning set by the different degrees of performance impairment.

Hypothesis 9. A significant interaction of factors "H" and "R" and "C" as a function of the differential effects on acquisition of discrimination learning set by the different kinds of discrimination impairment.

Hypothesis 10. A significant interaction of factors "J" and "K" as a function of the proactive inhibition resulting from use of irrelevant cues.

Hypothesis 11. No significant main effects or interactions of any kind if all groups utilize only relevant cues in correct manner with only minor chance fluctuations in performance.

It is recommended that the procedure be mechanized to provide reinforcement via immediate and automatic feedback of "correct" and "incorrect" nature of the given response as appropriate. It is recommended further that the procedure be so mechanized and controlled as to enable separate and distinct experimentation with visual and tactile sensory input. Further, the remaining blocks after each response should be re-arranged in accordance with tables of permutations and combinations to neutralize position effects. Time of each response should be measured in hundredths of a second from instant of exposure to instant of overt response.

Statistical Analysis:

Perform a complete analysis of variance of the discrimination test data in accordance with the following factorial design:

G x J x C x K x i

where the notation signifies:

G = 3 groups of achievers

J = 2 sequences of trials

C = 3 categories of stimuli

K = 3 stimuli per category

i = 90 individuals per group

Also perform a complete analysis of variance of the pretraining data and the major performance data in accordance with the following factorial design:

G x H x J x R x C x K x i

where the notation signifies:

G = 3 groups of achievers

H = 3 sub-groups of discriminators

J = 3 sub-groups of discriminators

J = 6 problems

R = 4 stages of practice

C = 4 differential sub-stages

K = 5 components per problem

i = 30 individuals per sub-group

Design #2

Subjects

1. Select 180 mentally retarded subjects, plus a reserve group of 18 for attrition, by criteria 1, 2, and 4 described in design #1.

2. Divide the main group into six groups (each N = 30) on the basis of pretraining performance scores. That is, rank the entire main group on the basis of said scores; divide the ranks into six blocks of 30 individuals; randomly assign 5 individuals from each block to each of the six experimental and control groups as indicated by the 3 x 2 design below:

Practice Treatments

Test Channels	TACTILE	VISUAL	NONE
TACTILE	E1a	E2a	Ca
VISUAL	E1b	E2b	Cb

Practice on problems 1 and 5 (requiring repeated discrimination reversal, if using irrelevant cues) on a distributed practice schedule totaling at least 60 presentations in alternating pattern (1, 5, 1, 5, 1, etc.) Record reaction time.

Test by means of problem 6 by appropriate channels.

Systematically rearrange blocks after every response to neutralize position effects by counterbalancing. Test for retention after 1 day, 1 week, and 1 month.

This design permits testing of the following hypothesis:

Hypothesis 1. Acquisition of learning set will develop at differential rate and efficiency for the two kinds of practice.

Hypothesis 2. Visual practice followed by tactile test should reveal the nature of cues dominant in the learning set.

Hypothesis 3. Tactile practice should yield significantly superior results by either test.

Hypothesis 4. Retention will reveal a differential rate of forgetting for the two practice treatments.

Hypothesis 5. The curve of forgetting will have the same basic shape for both practice treatments but will be merely displaced to a later time stage for tactile practice.

Hypothesis 6. The inter-problem by intra-problem, "jk", interaction will reveal the use of irrelevant peripheral cues.

Hypothesis 7. The use of irrelevant peripheral cues should be extinguished by practice with immediate feedback for reinforcement.

Statistical Analysis:

Perform a complete analysis of variance of the pre-training data, the practice data, and the test data for the experimental groups in accordance with the following factorial design:

P x T x J x K x i

where the notation signifies:

P = 2 practice treatments
T = 2 test channels
J = 5 problems
K = 5 components per problem
i = 30 individuals per group

Also perform a complete analysis of variance of the pre-training data and the test data for both experimental and control groups in accordance with the following factorial design:

P x T x J x K x i

where the notation signifies:

P = 3 practice treatments
J = 3 problems
T, K, i = same as above.

Design #3

Subjects:

Select 100 mentally retarded subjects, plus a reserve group of 10 for attrition, on the basis of criteria 1, 2, and 4 in design #1.

Divide the main group into two matched groups (N = 50) on the basis of pretraining performance scores. That is, rank the entire main group on the basis of said scores; divide the ranks into two blocks; randomly, or by a counter-balanced system, assign 25 individuals from each block to each of the matched groups. One group will be used as the experimental group for the full treatment. The other will become the control group and receive only the criterion task.

Procedure:

Administer an oddity discrimination test with ten appropriate combinations of the ten blocks from problems 1 and 5 taken three at a time. Reinforce the choice of the block with the odd-sized hole.

Administer an oddity discrimination test with ten appropriate combinations of the ten blocks from problems 3 and 4 taken three at a time. Reinforce the choice of the odd peripheral shape.

Administer an oddity discrimination test with ten appropriate combinations of the ten blocks from problems 8 and 9 taken three at a time. Reinforce the choice of the odd-shaped hole.

Administer an oddity discrimination test with ten appropriate combinations of the ten blocks from problems 1 and 5 taken three at a time. Reinforce the choice of the odd-sized peripheral shape.

Repeat these tests in sequence determined by one 4 x 4 Latin square until position effects are counterbalanced.

Administer the set of four problems in the counterbalanced design shown in suggested research design #1. This shall be known as the criterion task with four stages of practice. Distribute the administration schedule into four stages of four problems each on four separate days (R_1 = day 1; R_2 = day 2, etc.)

Statistical Analysis:

Perform a complete analysis of variance of the scores on the 16 training tasks in accordance with the following factorial design:

$J \times R \times C \times K \times i$

where the notation signifies;

J = 4 problems - oddity choice

R = 4 stages of practice

C = 4 sub-stages

K = 10 components per problem

i = 50 individuals

Perform a complete analysis of variance of the criterion data in accordance with the following factorial design:

G x J x R x C x K x i

where the notation signifies:

G = two groups of subjects
J = 4 block-assembly problems
R = 4 stages of practice
C = 4 differential sub-stages
K = 5 components per problem
i = 50 individuals per group

Prepare a table of intercorrelations of the time data on all the 16 training tasks, on all the 16 problems of the criterion task, and the 16 selected residuals of the J x K interaction of the criterion task.

By means of factor analysis determine the factor loadings for the relevant and irrelevant cues during the successive stages of practice.

V. SUMMARY

This investigation of insight and problem-solving behavior in mental retardates involved the cooperation of 60 subjects, half of them selected from the Southern Colony Training School, Union Grove, Wisconsin, and the other half selected from the primary special classes of the Madison Public Schools, Madison, Wisconsin. The older Southern Colony group averaged 21 years of age. The contrasting Madison group averaged only 9 years of age.

Two experiments were conducted with both of these groups of subjects. The first experiment was a measure of their performance on a sequence of six different block-assembly problems having identical relevant cues for solution but having quite varied peripheral cues. This was the measure of performance utilized for analysis of their problem-solving behavior. However, at the conclusion of this sequence of problems, an advanced test composed of three additional problems was administered for the purpose of sub-dividing each main group of subjects into two equal sub-groups according to their success or failure in adaptation to the advanced task. The three problems of the advanced task were presented simultaneously and were characterized by varied relevant cues for solution but identical peripheral cues contrary to their preceding experiences. Thus widely divergent grouping on an achievement dimension was superimposed upon the basic grouping on the general developmental dimension in a balanced factorial design.

The second experiment was a visual discrimination and matching test. By means of a tilting apparatus the apparent size and shape of a plane figure was varied systematically, and the subjects were directed to match the stimulus with one of the five anchors provided for judgment. The anchors were photographs of the stimulus taken at five different uniformly-spaced positions of tilt. The functions of visual spatial-pattern discrimination and abstraction of interrelationships among relevant peripheral cues were analyzed.

The general results were as follows:

1. The grouping dimension of general developmental maturity in mental retardation made a significant difference in speed of problem solving, but it made no difference on the discrimination task.

2. The grouping dimension of adaptation to the advanced task made an equally significant difference in speed of problem solving, but again it made no difference on the discrimination task.

3. Negative transfer or proactive inhibition functioned at a significant level on the block-assembly task for all groups on the basis of irrelevant peripheral cues.

4. Positive transfer or facilitation functioned at a significant level for all groups on the basis of a single

gross differentiation of the largest hole in a given set of blocks, the latter differentiation being subject to being completely overwhelmed by peripheral cues when maneuvered into opposition.

5. Speed of overcoming interference and eliminating errors on components of each problem differentiated the groups on each grouping dimension as indicated by significant groups x components interactions. The adaptation dimension produced a more clear-cut interaction.

6. Differential flexibility of attention set as a function of design-inherent convergence of attention on relevant cues in the problems was hypothesized to account partially for the differences in speed of problem solving by the groups.

7. Spatial-pattern discrimination of all the different-sized holes in the blocks and of the groups of apparently different-sized ellipses in these experiments was conspicuously absent for all these groups per se, but a few individuals made significant discriminations.

8. Gross size differentiation of the apparently different-sized ellipses was significant for the entire sequence of discrimination-matching tasks but not for any subdivisions of the sequence.

9. Intensity-brightness differentiation at rudimentary levels of neural functioning was hypothesized to account for the gross size differentiations in the absence of spatial-pattern discrimination and abstraction of relationships.

This investigation sought to locate ~~raises the question as to what are~~ the determinants of significant differences in speed of problem solving between groups when they are all significantly influenced by the same pattern of positive and negative transfer based on irrelevant peripheral cues primarily and secondarily on a weak size differentiation. A more specific question ~~asks~~ asked what innate structural conditions and previous learning experiences for the mentally retarded facilitate speed of problem solving despite negative transfer.

omit ~~In light of the experiments reported herein it would seem~~ It was concluded that training for the more severely impaired mentally might well be concentrated on manipulation of the intensity-brightness and the peripheral characteristics of training materials. If mental retardates are predisposed to strongest reactivity via those particular channels, the conclusion would seem to follow that efficient training should utilize this predisposition.

The final section of this report offered suggestions for further research. These were presented both in general and in highly specific forms.

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